VOLUME LVII NUMBER 2 WHOLE 499

SCHOOL SCIENCE AND MATHEMATICS

FEBRUARY 1957

School Science and Mathematics

A Journal for All Science and Mathematics Teachers

All matter for publication, including books for review, should be addressed to the editor. Payments and all matter relating to subscriptions, change of address, etc. should be sent to the business manager.

Entered as second class matter December 8, 1932, at Menasha, Wisconsin, under the Act of March 3, 1879. Published Monthly except July, August and September at 450 Ahnaip St., Menasha, Wis. PRICE, Four dollars and fifty cents a year; foreign countries $5.00; current single copies 75 cents.

Contents of previous issues may be found in the Educational Index to Periodicals.

Copyright 1957, by the Central Association of Science and Mathematics Teachers, Inc.

Printed in the United States of America

GLEN W. WARNER
Editor
Lakeville, Indiana

GEORGE G. MALLINSON
Assistant Editor
Kalamazoo, Michigan

RAY C. SOLIDAY
Business Manager
Box 408, Oak Park, Ill.

DEPARTMENTAL EDITORS

BIOLOGY—Paul E. Kambly
University of Oregon, Eugene, Ore.

Nelson L. Lowry
Arlington Heights High School, Arlington Heights, Ill.

CHEMISTRY—Gerald Osborn
Western Michigan College, Kalamazoo, Mich.

CONSERVATION—J. Henry Sather
Western Illinois State College, Macomb, Ill.

ELEMENTARY SCIENCE—Milton O. Pella
The University of Wisconsin, Madison, Wis.

GENERAL SCIENCE—John D. Woolever
Sarasota Public Schools, Sarasota, Fla.

MATHEMATICS—Cecil B. Read
University of Wichita, Wichita, Kan.

MATHEMATICS PROBLEMS—Margaret F. Willerding
Harris Teachers College, St. Louis, Mo.

NATURE STUDY—E. Laurence Palmer
Cornell University, Ithaca, N.Y., and The American Nature Association.

PHYSICAL SCIENCE—B. Clifford Hendricks
Hastings College, Hastings, Neb.

PHYSICS—E. Wayne Gross
R.R. 6, Bloomington, Ind.

Turtox Plastic
and Polyethylene
Field and Laboratory Ware

Turtox offers a large selection of boxes, jars, vials, bottles and standard laboratory ware such as graduates, beakers and battery jars made of shatterproof plastics and polyethylene. Refer to the current Turtox Biology Catalog No. 58, or write for descriptive pricelists.



GENERAL BIOLOGICAL SUPPLY HOUSE
Incorporated
8200 SOUTH HOYNE AVENUE
CHICAGO 20, ILLINOIS
The Sign of the Turtox Pledges Absolute Satisfaction

Please Mention *School Science and Mathematics* when answering Advertisements

A new algebra series outstanding in content, format, and color

FIRST YEAR ALGEBRA
SECOND YEAR ALGEBRA

Walter W. Hart

Veryl Schult

Henry Swain

These new algebras integrate a modern point of view with all the valuable features of the earlier Hart books—sound approach, clear and concise phrasing, excellent organization of material with the emphasis on a logical development, tested instructional methods, thorough training for skills, an ample number of carefully graded problems and exercises. Both books have attractive and effective formats with a variety of devices to make both teaching and learning easier.
Answers, Teacher's Manuals, Keys

D. C. HEATH AND COMPANY

Sales Offices: Englewood, N. J., Chicago 16
San Francisco 5, Atlanta 3, Dallas 1
Home Office: Boston 16

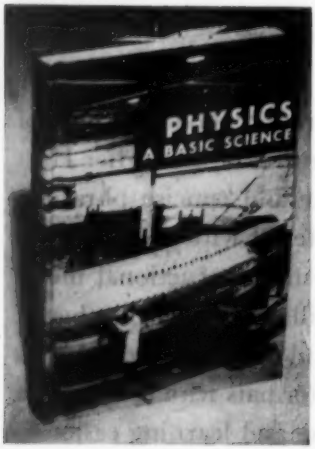
New for 1957!

CHEMISTRY—A BASIC SCIENCE

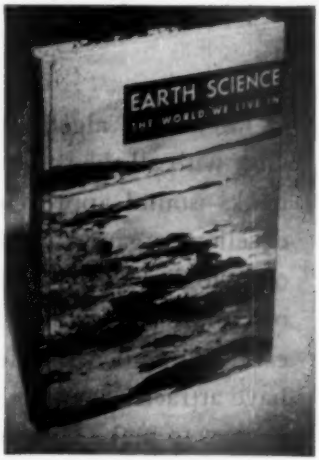
Hogg, Alley, Bickel

The fourth edition of this text, formerly entitled *Chemistry: A Course for High Schools,* reflects the latest advances in chemistry. The unit on nuclear theory is greatly expanded to include the many developments and discoveries of the past few years and to emphasize the peaceful uses of atomic energy. The chapters on the atomic theory and chemical arithmetic are completely rewritten.

Ready this Spring



PHYSICS—
A BASIC SCIENCE
Third Edition
Burns, Verwiebe,
Hazel, Van Hooft



EARTH SCIENCE—
The World
We Live In
Namowitz, Stone

D. VAN NOSTRAND COMPANY, INC.
120 Alexander Street Princeton, New Jersey

Dark! Well, and what of that,
Did'st fondly dream the sun would never set.
Dost fear to lose thy way? Take courage yet
Learn thou to walk by faith, and not by sight
Thy steps will guided be and guided right.
I hold not with the pessimist that all things are ill, nor with the optimist that all things are well.
All things are not ill and all things are not well, but all things shall be well, because this is God's world.

—BROWNING

CONTENTS FOR FEBRUARY, 1957

Constructing the Common Cross-Number Puzzle—*Louis Grant Brandes* . . 89

Apparently Free Insurance—*R. F. Graesser* 99

What Are Some of the Important Factors to Consider in a Program of Identifying the Gifted Pupil in Mathematics and Science?—*Monte S. Norton* 103

Hybridization in Poultry Breeding—*E. E. Schnetzler* 109

Attitudes in the Mathematics Classroom—*Donovan A. Johnson* 113

Integration of Arithmetic with Science Through the Study of Weather in the Elementary School—*M. Ira Dubins* 121

The Use of a Readiness Test in Teaching a Unit of Signed Numbers—*Clarence E. Olander* 131

Fire as a Subject in Elementary and General Science—*John D. Woolever* . . 139

Magnetic Models for Complex Ions and Molecules: Coordination Number Four—*Wesley W. Wendlandt* 145

A Planetarium for the Amateur Astronomer—*Wallace A. Hilton* 147

On a Derivation of $a = v^2/r$—*Julius Sumner Miller* 148

Meet Mr. Tau Again—*John Satterly* 150

Central Association of Science and Mathematics Teachers. Report of the Fifty-Sixth Convention—*Virginia Terhune* 152

Problem Department—*Margaret F. Willerding* 156

Books and Pamphlets Received 162

Book Reviews 162

School Science and Mathematics

—a journal devoted to the improvement of teaching of the sciences and mathematics at all grade levels.
—nine issues per year, reaching readers during each of the usual school months, September through May.
—owned by The Central Association of Science and Mathematics Teachers, Inc., edited and managed by teachers.

SUBSCRIPTIONS—$4.50 per year, nine issues, school year or calendar year. Foreign $5.00. No numbers published for July, August, September.

BACK NUMBERS—available for purchase, more recent issues 75¢ per copy prepaid with order. Write for prices on complete annual volumes or sets. Consult annual index in December issues, or Educational Index to Periodicals, for listings of articles.

The following interesting topics are discussed in issues of 1955:

Designing a Basic Science Course—Mathematics Courses for Engineers—Unit of Work on Sound—Evaluation Program in Mathematics—How Good Teachers Teach Science—Identification of Potential Scientists—Detection of Atomic and Nuclear Radiations—Semimicro Laboratory Procedure—Endless Numbers—The Science Fair—How to Choose a Textbook—Pick The Right Job—Five Basic Ways to Improve Science Courses.

USEFUL REPRINTS—(orders for reprints must be prepaid)

Atomic Energy: A Science Assembly Lecture, Illustrated	.25
Mock Trial of B versus A—A play for the Mathematics Club	.30
How Much? A Mathematics Playlet	.25
100 Topics in Mathematics—for Programs or Recreation	.25
Poison War Gases	.20
New Emphases in Mathematical Education, with bibliographies	.25
Mathematics Problems From Atomic Science	.25
The Mathematics of Gambling	.25
Optical Illusions: for high school mathematics	.25
Computations With Approximate Numbers	.25
The Radical Dream—A Mathematical Play for Puppets	.20
How Water Serves Man. A teaching unit	.20
Won by a Nose. A Chemistry play	.25
Radioactive Isotopes: A Science Assembly Lecture, illustrated	.25
Kem: Two Games for Chemistry Classes	.15
Modern Periodic Arrangements of the Elements; illustrated	.25
Ion Visits the Realm of Air. A Play	.25
The King of Plants. A play for science clubs	.25
Three Families of Great Scientists: dramatized	.30
Some Lessons About Bees. A 32-page booklet; illustrated	.20
The Triumph of Science. A play for auditorium programs	.25
In a Sound Studio. A play: Physics and Music	.25
In Quest of Truth. A play in two parts	.25
A Student's Approach to Mechanics	.25
Youth Looks at Cancer. A biology play	.25
Apparatus for Demonstrating the Fundamentals of Radio	.20
Youth Opens the Door to Cancer Control, bibliographies	.25
Vitalizing Chemistry Teaching. A Unit on the Halogens	.15
A Scientific Assembly Program, Wonders of Science	.30
What Is Scientific Method?	.20
Elementary School Science Library	.20
Projection Demonstrations in General Science	.20
Atomic Energy—A Play in Three Scenes	.30
Motion Pictures for Elementary Science	.25

SCHOOL SCIENCE AND MATHEMATICS

Price $4.50—Foreign $5.00

P.O. Box 408 Oak Park, Ill.

NO OTHER Electrostatic Generator Provides ANY Of these Features:

- *Universal* Motor Drive, designed for operation on 110-volt A.C., or 110-volt D.C.
- *Electronic* Safety Valve, to protect the motor against a random high-voltage surge.
- *Removable* Discharge Ball, which the demonstrator may use as a wand.
- *Flat Top* Discharge Terminal (with built-in jack) to receive various electrostatic accessories.
- *Endless* Charge-Carrying Belt, of pure latex, which may be driven at high speed without "bumping."

ALL of the foregoing features are *standard equipment* in CamboscO Genatron No. 61-705.

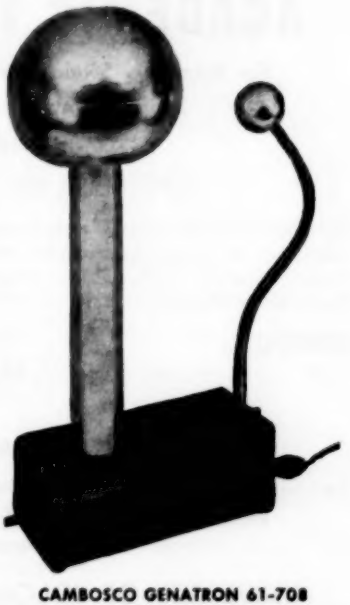


CAMBOSCO GENATRON 61-705

In addition, CamboscO Genatron No. 61-708 incorporates a built-in speed control, to facilitate demonstrations requiring less than maximum voltage.

The Output, of either model of the CamboscO Genatron, ranges from a guaranteed minimum of 250,000 volts to a maximum, under ideal conditions, of 400,000 volts. Yet, because the current is measured in microamperes, and the discharge duration is a matter of microseconds, no hazard whatever is involved for operator or observer.

- *May we tell you more?*



CAMBOSCO GENATRON 61-708

CAMBOSCO SCIENTIFIC CO.

37 ANTWERP ST. • BRIGHTON STATION

BOSTON, MASS., U.S.A.

Latest revision . . .

REFRESHER ARITHMETIC

by Edwin I. Stein

Recognizing the increasing need for basic arithmetic in so many areas of today's world, Stein's *new* REFRESHER ARITHMETIC has been expanded from 2 to 4 parts. Larger type and format . . . added color . . . develops and maintains high degree of proficiency in practical mathematics.

Please write to the office nearest you for further information

and

Allyn and Bacon, Inc.

BOSTON • ENGLEWOOD CLIFFS • CHICAGO • ATLANTA
DALLAS • SAN FRANCISCO

ACADEMIC YEAR INSTITUTE

For Secondary School Teachers of Science and Mathematics
Sponsored by the University of Colorado and
The National Science Foundation

SEPTEMBER 23, 1957, TO JUNE 6, 1958

The purpose of this program is to improve the quality of science teaching by providing opportunity for 50 selected secondary school teachers (Grades 9-12) to increase their knowledge in the science fields. Specially designed courses in Biology, Chemistry, Mathematics and Physics will be offered.

STIPENDS:

$3,000 Each, Plus Allowances for Dependents, Travel, Tuition and Books

APPLICATIONS MUST BE RECEIVED BY MARCH 1, 1957

For Information and Application Forms Write:

PROFESSOR WILLIAM E. BRIGGS, PROGRAM DIRECTOR
Department of Mathematics

UNIVERSITY OF COLORADO, BOULDER, COLORADO

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS—OFFICERS FOR 1957

President: Edward Bos, Proviso Township High School, Maywood, Ill.
Vice-President: Louis Panush, Northeastern High School, Detroit, Mich.
Secretary-Historian: Virginia Terhune, Proviso Township High School, Maywood, Ill.
Treasurer-Business Manager: Ray Soliday, Oak Park High School, Oak Park, Ill.

EXECUTIVE COMMITTEE FOR 1957

Edward Bos, President
Louis Panush, Vice President
Charlotte W. Junge, President for 1956, Wayne University, Detroit, Mich.

BOARD OF DIRECTORS FOR 1957

Ex-Officio

Edward Bos, President
Louis Panush, Vice President
Charlotte W. Junge, President for 1956

Terms Expire in 1957

Wayne Gross, Laboratory School, Indiana University, Bloomington, Ind.
Ralph C. Huffer, Beloit College, Beloit, Wis.
Clyde T. McCormick, Illinois State Normal University, Normal, Ill.
Alice Hach, Board of Education, Racine, Wis.

Terms Expire in 1958

Lawrence Conrey, University School, Ann Arbor, Mich.
Sister Mary Evarista, Mercy High School, Chicago, Ill.
Cecil Read, University of Wichita, Wichita, Kan.
F. Lynwood Wren, George Peabody College, Nashville, Tenn.

Terms Expire in 1959

H. Glenn Ayre, Western Illinois State College, Macomb, Ill.
Francis Gourley, LaPorte High School, LaPorte, Ind.
Walter E. Hauswald, Sycamore High School, Sycamore, Ill.
Luther Shetler, Bluffton College, Bluffton, Ohio

EDITOR OF THE YEARBOOK

Luther Shetler, Bluffton College, Bluffton, Ohio

JOURNAL OFFICERS

Glen W. Warner, Editor, Lakeville, Ind.
George G. Mallinson, Assistant Editor, Western Michigan College, Kalamazoo, Mich.

SECTION OFFICERS FOR 1957

(Order: Chairman, Vice Chairman, Secretary)

Biology

Lula W. Casemore, Mackenzie High School, Detroit, Mich.
William A. Hill, Community High School, Naperville, Ill.
Morris J. Pumphrey, Arlington Heights High School, Arlington Heights, Ill.

Chemistry

Robert L. Walker, Lyons Township High School and Junior College, LaGrange, Ill.
Arthur Reynolds, Northern High School, Detroit, Mich.
Gerald Alexander, Ball State Teachers College, Muncie, Ind.

Conservation

Marvin Bell, Indiana State Teachers College, Terre Haute, Ind.
Muriel Beuschlein, Chicago Teachers College, Chicago, Ill.
Rex Conyers, University City High School, University City, Mo.

Elementary Mathematics

Elinor B. Flagg, Illinois State Normal University, Normal, Ill.
Sheldon Myers, Educational Testing Service, Princeton, N. J.
Geraldine Kauffman, 4819 Magoun Avenue, East Chicago, Ind.

Elementary Science

Frank O. Youkstetter, Wayne University, Detroit, Mich.
Sister Mary Lorita, St. Xavier College, Chicago, Ill.
Theodore Wallschlaeger, Palmer Elementary School, Chicago, Ill.

General Science

Fred L. Keil, Proviso Township High School, Maywood, Ill.
Sister Mary Ambrosia, Immaculata High School, Detroit, Mich.
Newton G. Sprague, Instruction Center, Indianapolis Public Schools, Indianapolis, Ind.

Mathematics

Hobart Sistler, J. Sterling Morton High School, Cicero, Ill.
Leonard Antel, Adult Education Day School, Detroit, Mich.
Paul Schuette, Wisconsin High School, Madison, Wis.

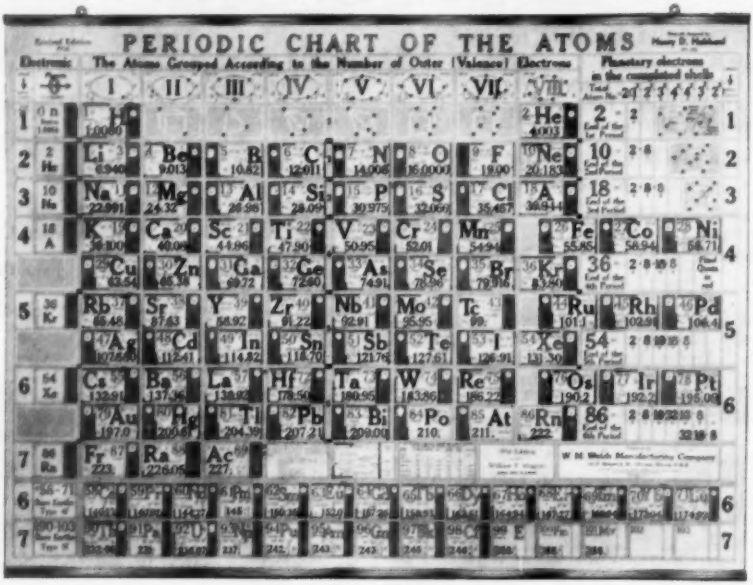
Physics

Robert L. Price, Joliet Junior College, Joliet, Ill.
Robert E. Carpenter, Richmond Senior High School, Richmond, Ind.
Paul S. Godwin, Thornton Junior College, Harvey, Ill.

Welch—Chart of the Atoms

1956 EDITION

As indispensable as an up-to-date calendar



No. 4854

This extensive revision shows the latest International Chemical Society Atomic Weights, a comprehensive tabulation of Isotopes, and latest data on all 101 elements—Also carries the most recent information about the Transuranic Elementa, including—
Berkelium, Californium, Einsteinium, Fermium, and Mendelevium

The Periodic Chart of the Atoms, published exclusively by Welch, is recognized throughout the world as a most authoritative and comprehensive presentation of the principal facts about all known atoms, including the artificial transuranic elements recently manufactured. It is sufficiently detailed to serve the most advanced workers in atomic physics, yet presents basic facts clearly to students of elementary high school chemistry and physics.

No. 4854. CHART OF THE ATOMS 1956 Edition. With formed-metal molding at top and bottom with eyelets for hanging, non-glare protective coating with key booklet ..... Each $7.50

WRITE FOR CIRCULAR

W. M. Welch Scientific Company
DIVISION OF W. M. WELCH MANUFACTURING COMPANY
Established 1880
1515 Sedgwick St. Dept. S Chicago 10, Ill., U.S.A.
Manufacturers of Scientific Instruments and Laboratory Apparatus

SCHOOL SCIENCE
AND
MATHEMATICS

VOL. LVII FEBRUARY, 1957 WHOLE NO. 499

CONSTRUCTING THE COMMON CROSS-NUMBER PUZZLE[1]

LOUIS GRANT BRANDES
Encinal High School, Alameda, Calif.

Why construct original puzzles? A book of selected cross-number puzzles will likely suffer the same shortcoming as most mathematics texts or workbooks. In using a text or workbook with a class of pupils, it is necessary to adapt the children to the content of the publications used, rather than to adapt the materials to the children. If a teacher wishes to cover specific materials or subject areas with individual classes, or with individual pupils, it is often necessary for him to provide such materials by his own initiative. Such teacher-improvised materials have the advantage of meeting the needs of a class or group of pupils at a specific time and place. Teacher-constructed cross-number puzzles serve this purpose.

Pupils may also wish to create original puzzles. If the children are to be successful in this endeavor, their teacher must take time to explain the make-up of the puzzles, along with the procedures that will assist in constructing them.

It is for the purpose of providing suggestions for the construction of original cross-number puzzles that this article is presented.

Suggestions from the literature. A sub-topic of an article appearing in the *Mathematics Teacher* provides some good suggestions for making cross-number puzzles.[2] These suggestions are as follows:

"1. Select a basic square pattern (puzzle block) to follow; 6 by 6, 8 by 8, or 12 by 12.

[1] This article consists of excerpts from *A Collection of Cross-Number Puzzles*, by Louis Grant Brandes (J. Weston Walch, Publisher, Box 1075, Portland Maine, 1957, 226 p.).

[2] Berger, E. J. (Editor) "Devices for a Mathematics Laboratory," *The Mathematics Teacher*, January, 1951, pp. 31–34.

Please Mention *School Science and Mathematics* when answering Advertisements

"2. Select from two to four definitions or problems per row horizontally; also follow this pattern vertically.
"3. Each answer to a problem or definition (item) should not be longer than can be written in four squares (cells) in any one row.
"4. State each definition or problem very briefly. When making problems for the horizontal rows, very little difficulty will be found.
"5. In selecting problems for the vertical rows a little clever thinking may be needed to find problems with answers that will fit the number combinations already given by the horizontal definitions and problems.
"6. Select a title for each puzzle to add to its interest. The following are suggestive: Areas and Perimeters, Whole Number Processes, Volumes, Units of Measure, and General Processes.
"7. In the beginning it is better to start with short puzzles than to plan long ones. In order to maintain student interest at a high level it is best not to include more than twenty-five items horizontally and the same number vertically."

From experience in making the puzzles, the writer has found several exceptions to the suggestions. One of the suggestions indicates that answers to problems should not be longer than four squares (or cells). The writer feels that the number of squares (or cells) used for the answer to a problem depends on the number necessary to provide the answers for a specific problem, rather than a limited size number of four digits. If the desired coverage of material in some subject areas is to be provided, the answers to some problems should contain six or more digits, and thus require six or more squares (or cells) in the puzzle block.

Another of the suggestions indicates that problems should be stated very briefly. Though this is generally true, there are exceptions to be considered. If one of the purposes of using cross-number puzzles is to cover written problems, then a number of such problems should be rather lengthy. Also, problems should be stated in a variety of ways, if pupils are to gain complete understanding of specific processes.

The suggestion that the puzzles "not include more than twenty-five items horizontally and the same number vertically" is, for the most part, a good one. However, if the time necessary for most pupils to complete the puzzles, and the broad range of items necessary to adequately cover some topics, are taken into consideration, then twenty-five items may not prove a sufficient number of items for some puzzles.

Some simple puzzle blocks for beginners have been suggested by Willerding.[3] These blocks are squares with five cells on a side, as illustrated in Fig. 1.

The puzzle blocks of most cross-number puzzles that have found their way into the literature are in the form of a square with thirty-six, forty-nine, sixty-four, eighty-one, or one hundred twenty-one cells. Though the square is the easiest block to construct, the puzzle

[3] Willerding, Margaret F., "Review the Fundamental Processes; The Cross-Number Puzzle," School Science and Mathematics, January, 1954, pp. 51-52.

block can be in any form or shape. Some contributers have added variety to their puzzles by making the blocks in such forms as a ship, motor car, Christmas tree, and others.

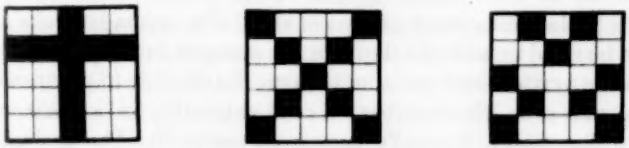


FIG. 1. Simple puzzle blocks.

Suggestions by the writer. From the experience gained by constructing a considerable number of cross-number puzzles, along with working with teachers and pupils who have produced original puzzles, the writer offers the suggestions that follow for those undertaking the construction of original puzzles.

1. *Select a topic.* Beginners had best select a topic of a general nature, such as general review, rather than a specific subject area, such as finding the per cent of a number. The more specific the subject area, the more likelihood of difficulty in completing a useful puzzle. After experience is gained by making puzzles of a general nature, the beginner might try more specific areas such as whole numbers, fractions, decimals, per cent, measures, etc. After still more experience, the neophyte can try specific areas such as addition of whole numbers, multiplication of fractions, division of decimals, finding a number when the per cent of it is known, etc.

2. *Choose a block for the puzzle.* While a uniform puzzle block, such as a square, is easy to construct, the block is not limited as to size or shape. Until experience is gained, however, it seems logical to begin with a square block. As a starter, the number of cells should be

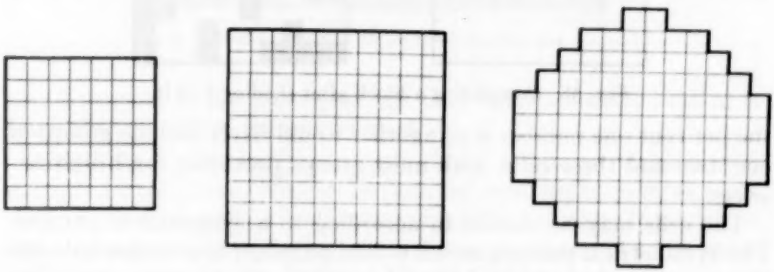


FIG. 2. A number of puzzle designs.

limited to thirty-six, forty-nine, or sixty-four cells; or squares with six, seven, or eight cells, respectively, on a side. Puzzles with one-hundred cells can be attempted after experience has been gained by

constructing smaller puzzles. A number of puzzle blocks are shown in Fig. 2. One of the blocks consists of forty-nine cells; another block is made up of one hundred cells.

3. *Shade in cells.* Shade in cells in the puzzle block so that the block is broken into small groups of cells. The unshaded cells are the cells to be filled in with the digits of the answers to the problems making up the vertical and horizontal items. Each digit of an answer will occupy one cell. The number of cells extending in a horizontal or vertical direction will usually vary from one to six. The desired number of cells in a group will depend on the topic that the puzzle is designed to cover. For example, a puzzle on whole numbers would likely include all manner of groups from one to six or more cells, with most groups providing for 3- and 4-digit answers; a puzzle on finding

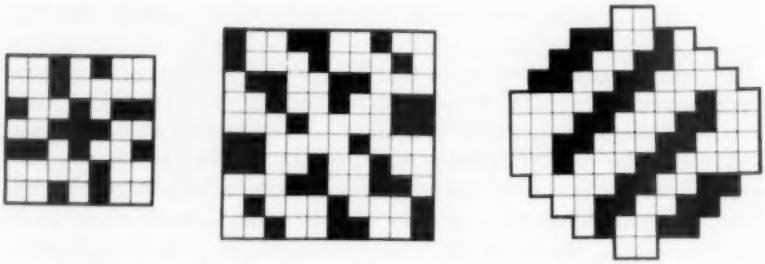


FIG. 3a. Some patterns for puzzle blocks.

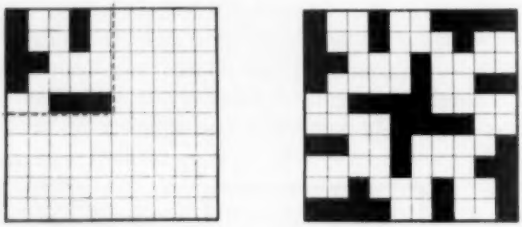


FIG. 3b. Completing a block after shading $\frac{1}{4}$ of it.

the per cent one number is of another would likely include groups of one, two and three cells, with most groups providing for 2-digit answers.

The cells may be shaded in according to a symmetrical pattern. The symmetrical pattern serves a dual purpose; it provides a design that most people find pleasing, and it enables the person constructing the puzzle block to plan for the number of items to be used, while in the act of shading the block. The number of items can be planned by working with a quarter or a half of the block, then shading in the other half, or three quarters, to complete the symmetrical pattern.

Care should be taken in shading cells to see that the puzzle block does not consist of too many or too few groups, and that the number of cells in a group vary in keeping with the selected topic.

A number of puzzle designs are shown in Fig. 3.

4. *Number the groups of cells.* Number the groups of horizontal and vertical cells so that each group of cells has a number. Place the number in the upper lefthand corner of a cell. Start with the uppermost horizontal line of cells and number consecutively the first cell of each horizontal and vertical group. Proceed from right to left and from the first horizontal line of cells to the second. Note how cells are numbered in the diagram in Fig. 4. Every horizontal group of cells will have a number in the leftmost cell that follows a shaded cell or is adjacent to the left side of the puzzle block. Every vertical group of cells will

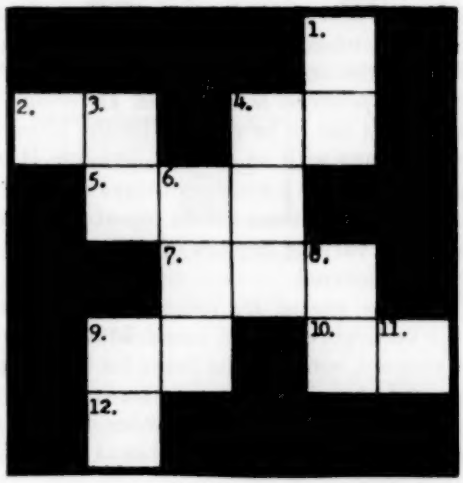


FIG 4. Diagram of numbering system.

have a number in the uppermost cell that follows a shaded cell or is below the top side of the puzzle block.

Sometimes it may be necessary to "cut" a number of horizontal and/or vertical items. This can be done by omitting to number some of the horizontal and/or vertical groups. For example, it would be convenient to omit numbering vertical group number 11 when numbering the groups in the diagram. Should this have been done, horizontal group number 12 would have been numbered 11. This would provide one less item in the vertical column. Another way in which items can be decreased is to include a number that designates both a horizontal and a vertical group. For example, the number 2 designates

a horizontal group of two cells and a vertical group of one cell; the number 2 item could be conveniently dropped from the vertical column of items.

5. *Number the items for the horizontal and vertical columns.* Indicate the numbers of the horizontal and vertical columns of items below the puzzle block. The numbers in the horizontal column should correspond with the numbered horizontal groups of cells; the numbers in the vertical column should correspond with the numbered vertical groups of cells. Room should be provided after and between the numbers in the horizontal and vertical columns to write in the problems or questions whose answers will be written in the correspondingly numbered groups of cells. A second sheet of paper will likely be needed to provide sufficient room.

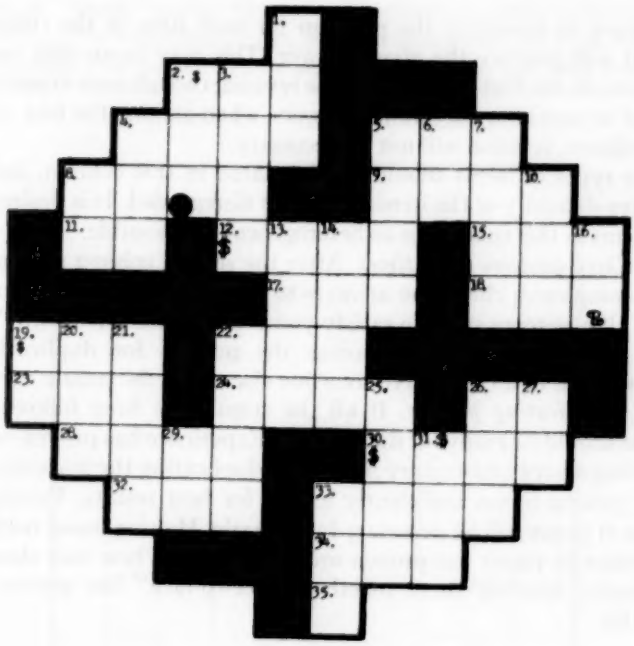
Confusion sometimes results when it is observed that the item numbers for the horizontal and vertical columns are not alike, nor are the numbers in a column consecutive. A review of the numbering procedure usually clarifies this confusion.

6. *List the types of problems to be covered.* Determine the different types of problems that are to be covered by the puzzle. Make a list of the types of problems with an example of each. If possible, state each of the types of problems a number of ways such as to add variety to the puzzle in cases where items will be repeated a number of times. Make problems with varying degrees of difficulty for each type of problem that will be covered.

7. *Provide items for one of the columns.* Begin with either the horizontal or the vertical column of items. Making use of the list of problems to be covered, compose the items for the entire column. As each item is completed, write the answer for it in the corresponding group of cells in the puzzle block. The number of digits in the answer to an item must correspond with the number of cells provided for the item in the puzzle block.

Alternate the types of problems covered as you progress with the column of items, continually referring to the list of types of problems to be covered. Try to arrange the column of items such that they become progressively more difficult. Start with the easiest items; complete the column with the more difficult items. Do not try to work with both columns of items at the same time.

8. *Complete the other column of items.* After completing one of the columns of items, begin work on the other column. Inasmuch as the answers to each of these items must correspond to the answers as they now appear in the puzzle block, write the answers for the items of this column adjacent to the item number. Use a colored pencil to write the answers; this will avoid confusing the item number and the desired answer. In providing the problems for these items it will be



Review Puzzle.

Horizontal

1. Duce.
2. Find the sum of 42; 375; 62; 223; and 9.
4. Multiply 38 by .37.
5. Divide: $.072\overline{)51.192}$
8. Subtract: 37 − 8.35.
9. Multiply 35.28 by 33 1/3 using the short method.
11. 5 5/8 × 2 2/3 × 1 1/5.
12. Annual salary at $677 per month.
15. 63 is 3/8 of what number?
17. Number of square inches in the area of a square whose sides measure 2 ft.
18. The number of days in a leap year.
19. Interest on $5,500 for 1 year at 5%.
22. Find the sum of the squares of 15 and 3.
23. Number of square inches in area of a circle having a diameter of 12 inches. (Drop fraction part of answer.)
24. Write MCMLVII as an Arabic number.
26. A man was born in 1871 and died in 1956. How many years did he live?
28. Number of days in 3 2/5 years.
30. A house valued at $9,500 was mortgaged for 65% of its value. What was the amount of the mortgage?
32. In Boise, Idaho the coldest temperature for one year was 32°F. below zero, while the hottest temperature for the same year was 103°F. above zero. What was the temperature range in number of degrees F. for Boise during this particular year?
33. Number of gallons capacity of a rectangular tank that is 4 ft. by 5 ft. by 8 ft. (Use 1 cu. ft. equal to 7.5 gallons.)
34. How many quarters does it take to make sixty dollars?
35. Solve: $\dfrac{7.5 \times 56 \times 4.32}{84 \times .45 \times 9.6}$.

Vertical

1. The multiplicand is 532; the product is 114,912. Find the multiplier.
2. Round off $716.49 to the nearest dollar.
3. 243 is 16 2/3% of what number?
4. Number of square feet in the total lateral area of a booth whose base is 6 ft. square and whose height is 9 ft.
5. Change 5 sq. yd. 4 sq. ft. 90 sq. in. to number of square inches.
6. Number of square yards in the area of a triangle whose base is 11 ft. and whose altitude is 18 ft.
7. Number of thousands in 1,713,000.
8. Decrease 28 by 25%.
10. The multiplicand is 37, the multiplier is 18. Find the product.
13. Divide 90,801 by 39.
14. Number of square feet of area in a rectangular lot 45 ft. wide and 61 ft. deep.
16. $860 is what per cent of $1,000.
19. Solve: 4 1/5 × 3 3/4 ÷ 3/4.
20. Find the square root of 505,521.
21. Change 1 hr. 28 min. 41 sec. to number of seconds.
22. Find the product of .45 and 4,700.
25. Subtract 8,319 from 15,943.
26. A rectangular lot is 238 ft. long and 197 ft. wide. Find its perimeter in number of feet.
27. How many short tons does a fishing boat weigh if it displaces 1,760 cu. ft. of fresh water? (Use 1 cu. ft. of fresh water equal to 62.5 lb.)
29. Number of nickles necessary to make $2.15.
31. Premium on a fire insurance policy for $16,000 at $6.25 per $1,000.
33. One-eighth of one thousand.

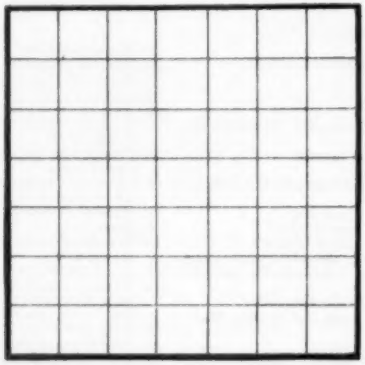
necessary to construct the problem for each item of the column so that it will produce the given answer. This may mean that some of the items in the first column must be revised; though once experience is gained in providing factorable answers, when making the first column of problems, revision will not be necessary.

The types of items should be alternated in this column, but progressive difficulty of the items should be disregarded. It is desired that the items in this column be as heterogeneous as possible.

9. *Check answers to all times.* After the second column of items has been completed, check the answers to all the problems for accuracy. Take all necessary steps to satisfy yourself that the puzzle will "work out" correctly. Before preparing the puzzles for duplication or presentation to a class, have someone else check the puzzle carefully.

10. ***Duplicating puzzles.*** If all the steps have been followed, the puzzle should be ready for duplication. Experience has proven mimeographing a very satisfactory method of duplicating the materials. The ditto process is not sufficiently legible for best results. Usually two sheets of paper will be necessary for a puzzle. Making use of both sides of a sheet of paper has proven unsatisfactory. Where two sheets are necessary, stapling them together "face-to-face" has proven most effective.

TITLE: _____



Horizontal *Vertical*

1. _____ _____

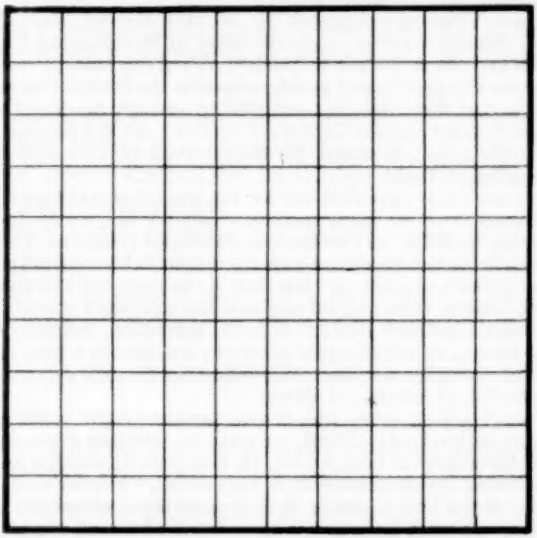
_____ _____

_____ _____

A puzzle form. If a number of puzzles are planned, or if a whole class plans to work on the construction of puzzles, a form for constructing them should prove very useful. Such forms are provided on the following pages, along with a completed puzzle. The puzzle forms

consist of "blank" puzzle blocks, with spaces to write in horizontal and vertical item numbers, titles, and horizontal and vertical columns of problems. The puzzle blocks may be revised in size and shape by

TITLE: _____



Horizontal *Vertical*

1. _____ _____

simply drawing straight lines through the unwanted portions of the blocks, or by redrawing the boundaries of new blocks in colored pencil. The forms can be prepared on a typewriter for duplication purposes.

URANIUM VS. COAL

Accept the fact that such a thing as a neutron exists, exactly as you accept the fact of electricity each time you switch on a light. Accept the fact, too, that if this neutron collides with the uranium 235 nucleus, a peculiar process called "fission" occurs. Two fission fragments fly apart at high velocity and let loose large amounts of energy.

Then consider that from one pound of fissionable uranium you get as much energy as from 2,600,000 pounds of coal. Now, you'll understand why enthusiasts grow so excited about atomic energy.

—L. R. HAFSTAD

Wall Stud Finder locates the stud by finding hidden nails securing it to the baseboard. It makes picture hanging easier for the home-owner. The two-inch device locates metal objects by use of a magnet imbedded in a plastic case. It can also be used to pick up pins and needles and locate nails in tires.

A PHILIPPINE STUDENT IN AMERICA

Economists may say that the future of the Philippines depends upon its industrial development but in fact there can be little industrial development without trained technicians. At Carnegie Institute of Technology in Pittsburgh, Pennsylvania a 24 year-old Filipino is doing graduate work in Metallurgical Engineering and will soon be one of the trained technicians that the Philippine industrial development will depend upon.

He is Antonio Villanueva Arizabel, Jr., of 1457 Merced, Paco, Manila—his country's first student to attend graduate school in Metallurgical Engineering at Carnegie Tech and one of the few Filipinos studying this subject anywhere.

The short, stocky, dark-haired youth arrived in the United States in September 1955 and in that short time has compiled an amazing academic and research record. His grade-point ratio at Carnegie Tech is 3.7 out of a possible 4.0—one of the highest in the graduate school. He has received 17 A's and 5 B's since beginning his studies at Tech!

While there are many opportunities for the trained metallurgical engineer in the United States there are many more in a country like the Philippines which is just beginning to utilize its enormous undeveloped resources. The training at Tech gives Antonio the benefit of experts in the field—not only educational leaders but educators who are also top men in the practical and research end of the field. The trained metallurgical engineer has unlimited opportunities available in the metals industry dealing with the extraction, refining, shaping and treatment of metals; in metallurgical research; and also in a wide range of electrical, chemical and other manufacturing industries that are dependent upon the effective utilization of metals and alloys.

Antonio began a long range educational program eight years ago when he graduated from high school in Manila—a program which he hopes will culminate in a Ph.D. in Metallurgical Engineering. He is at present working on his Masters Degree. "Following my graduation from high school," Antonio said, "I attended the University of the Philippines in Manila majoring in chemistry. At this time I wasn't quite sure what I wanted in the way of advanced education, so after graduation, in 1952, I worked for one year with Elizalde Mining Engineers as a analytical chemist and two and one-half years as a metallurgical chemist for Iligan Steel Mills in Iligan City, province of Lanao. While working for Iligan Steel I become interested in metallurgical engineering. I decided that this was the career field for me—a career which had unlimited possibilities for myself, one that I was greatly interested in and one that, because of the limited number of trained men, I could visibly contribute to my country's betterment."

Iligan Steel paid Antonio's salary for the first year he was studying in the United States. His transportation is covered by a Fulbright Fellowship and this year a good percentage of his expenses are paid through a Research Assistantship he received from Carnegie Tech. Going to school in the United States is not inexpensive and Antonio has discovered first hand the difference in the economies of the Philippines and the United States. "While I was fortunate," he said, "In receiving my pay from Iligan Steel for the first year, I rapidly discovered that what was a livable wage in my country was not in this country."

ABILITY AND EXPERIENCE COUNTS

Latest government studies indicate that a college graduate with a Bachelor of Science or an engineering degree can easily get a job paying $400 a month. Within not too many years, he should be up to $750 a month. Men who reach the higher levels of management will, of course, earn considerably more. In industry, salaries of $25,000 and $35,000 are not unusual.

"Show me a man of ability and experience, and I'll meet his price, whatever it is," the head of a large company in the atomic field recently remarked.

—L. R. HAFSTAD

APPARENTLY FREE INSURANCE

R. F. GRAESSER
University of Arizona, Tucson, Arizona

There is a type of life insurance, called return-of-premium insurance, which, at a first glance, might seem to be free insurance. This is because not only is the face value of the policy paid upon the death of the insured, but all of the premiums are returned as well. Yet an insurance company can still earn a profit on such insurance. Paradoxical as this seems, it is capable of a simple explanation, which will be given in what follows. No knowledge of actuarial mathematics is assumed in this explanation.

The amount A of a principal of P dollars accumulated for n years at the rate of interest i compounded annually is given by $A=P(1+i)^n$. P is also called the present value of A and equals $A(1+i)^{-n}$. It will be convenient to represent $(1+i)^{-1}$ by v and write

$$P=Av^n.$$

The mortality table commonly used by American life insurance companies is called the Commissioners 1941 Standard Ordinary Mortality Table. This table shows in a column headed l_x the number of persons surviving at each integral age x out of 1,023,102 persons born alive. Another column headed d_x shows the number of persons from this group who die between the integral ages x and $x+1$. Thus $d_x=l_x-l_{x+1}$. Other columns will be described as we need them. An insurance company assumes that the values of l_x and d_x for its group of policyholders are strictly proportional to the values of l_x and d_x given by the mortality tables which the company uses. Premiums are calculated for the group of lives represented by the mortality table and then applied for the group of lives represented by the company's policyholders.

To determine the premium on a return-of-premium policy, the present values, or net single premiums, on a life annuity, or pension, and on two kinds of life insurance are needed. A person aged x will be designated by (x). We proceed to find these net single premiums commencing with the annuity of one dollar per annum payable at the beginning of each year to (x) as long as (x) lives. This present value is represented in the literature by $\ddot{a}_x$. By our mortality table there are l_x persons now alive at age x to receive the first payment of our annuity, for which l_x dollars are needed. There will be l_{x+1} persons alive one year from now to receive l_{x+1} dollars, whose present value is vl_{x+1} dollars. Two years from now l_{x+2} dollars are needed with a present value of v^2l_{x+2}. The next payment requires l_{x+3} dollars with a present

value of $v^3 l_{x+3}$, and so on. Hence the present value of all future payments of the annuity is

$$l_x + v l_{x+1} + v^2 l_{x+2} + \cdots + v^{\omega-x} l_\omega,$$

where ω is the oldest age in the table. This present value, or total cost, divided among the l_x annuitants gives the cost to each, or the net single premium for an annuity of one dollar per annum. We modify this result by multiplying both dividend and divisor by v^x thus

$$(v^x l_x + v^{x+1} l_{x+1} + v^{x+2} l_{x+2} + \cdots v^\omega l_\omega)/v^x l_x.$$

The denominator of this expression is called D_x, and the numerator is called N_x so that

$$\ddot{a}_x = N_x/D_x. \tag{1}$$

The values of D_x and N_x, for the chosen rate of interest and for appropriate integral ages x, are tabulated in the mortality table.

The present value, or net single premium, on an insurance of one dollar payable at the end of the year of death of (x) is indicated by A_x. For l_x persons now insured in this manner d_x dollars will be needed for death claims at the end of one year. These d_x dollars have a present value of vd_x. For the death claims at the end of two years d_{x+1} dollars will be needed with a present value of $v^2 d_{x+1}$, and so on. The present value of this insurance for all l_x insured persons is

$$vd_x + v^2 d_{x+1} + v^3 d_{x+2} + \cdots + v^{\omega-x+1} dw,$$

which, divided among the l_x persons insured, gives the cost to each, or A_x. Again we multiply numerator and denominator of the resulting fraction by v^x obtaining

$$(v^{x+1} d_x + v^{x+2} d_{x+1} + v^{x+3} d_{x+2} + \cdots + v^{\omega+1} dw)/v^x l_x.$$

The denominator is D_x; the numerator is called M_x and is also tabulated for the chosen rate of interest and appropriate integral ages x. Hence

$$A_x = M_x/D_x. \tag{2}$$

Finally we need the present value, or net single premium, on an insurance that pays one dollar at the end of the first year if (x) dies within that year; two dollars at the end of the second year if (x) dies in the second year; three dollars at the end of the third year if (x) dies in the third year; and so on. The sum of the present values of the amounts needed at the ends of successive years is

$$vd_x + 2v^2 d_{x+1} + 3v^3 d_{x+2} + \cdots + (\omega - x + 1) v^{\omega-x+1} dw.$$

This present value, or total cost now, is divided among the l_x persons

insured; then the numerator and denominator of the resulting fraction is multiplied by v^x as before, thus giving

$$(v^{x+1}d_x+2v^{x+2}d_{x+1}+3v^{x+3}d_{x+2}+\cdots+(\omega-x+1)v^{\omega+1}dw)/v^x l_x.$$

Again the quantity in the numerator is tabulated for appropriate ages and the chosen rate of interest. It is called R_x, and the net single premium on our increasing insurance is designated $(IA)_x$. Hence

$$(IA)_x=R_x/D_x. \tag{3}$$

In order to care for the cost of doing business, agents' commissions, and profits for its stockholders, an insurance company has to charge higher premiums than the net premiums such as we have been calculating and which represent the actual cost to the company of the insurance furnished. These higher premiums actually charged the policyholders are called loaded premiums or office premiums. Let π be the net annual premium payable at the beginning of each year for the following insurance: one dollar payable at the end of the year of death of (x) together with the total of all his office premiums. Let π' be the annual office premium paid for this insurance by (x) at the beginning of each year in which he is alive. These returnable office premiums form an increasing insurance whose present value is $\pi'(IA)_x$ so that the total present value of the benefits to be received by the beneficiary of (x) is $A_x+\pi'(IA)_x$. The present value of the net premiums to be paid by (x) is $\pi\ddot{a}_x$. These two present values, of payments and of benefits, must be equal, hence

$$\pi\ddot{a}_x=A_x+\pi'(IA)_x. \tag{4}$$

Office premiums are often found by adding a certain per cent to the net premium plus a certain fixed amount per thousand dollars of insurance. Let k be this per cent expressed per dollar as a decimal and c be the fixed amount per thousand. Then

$$\pi'=\pi(1+k)+0.001c. \tag{5}$$

Solving (4) and (5) for π' by eliminating π, we have

$$\pi'=\frac{A_x(1+k)+0.001c\ddot{a}_x}{\ddot{a}_x-(IA)_x(1+k)}.$$

Using (1), (2), and (3), we have

$$\pi'=\frac{M_x(1+k)+0.001cN_x}{N_x-R_x(1+k)}. \tag{6}$$

This is the annual office premium on a return-of-premium insurance of one dollar. Of course, the office premium on any other amount is

found by multiplying (6) by that amount. To keep our discussion simpler, insurance payable at the end of the year of death has been considered, while insurance is usually paid immediately on the death of the insured. However, the difference in premiums for these two kinds of insurance is small. For the same reason only annual premiums have been considered. As a numerical example of (6), let $x=30$, $k=0.25$, and $c=2$. Using the tabulations for two and one-half per cent interest in the Commissioners 1941 Standard Ordinary Mortality Table, we find $M_{30}=182{,}403$, $N_{30}=10{,}594{,}280$, and $R_{30}=6{,}037{,}841$. Hence π' equals 0.081 784. This is the annual office premium on a one dollar policy. The premium on a thousand dollar policy is \$81.78, while the office premium on the same policy but without the return-of-premium feature is \$22.52. This shows why the premiums can be returned to the beneficiary. They are so high that the interest they earn is sufficient to pay for the insurance provided. Such high premiums would probably fail to have a popular appeal. Term insurance, limited-payment insurance (such as twenty-payment life), and endowment insurance could all be furnished with the return-of-premium feature, but with very high premiums.

PREPARATION FOR THE ANTARCTIC EXPLORATIONS

All-out effort in the huge 1957–58 program to give our planet its most exhaustive physical examination will carry scientists all over the world. United States participation is administered by the National Academy of Science and backed by a 13-million-dollar Congressional appropriation. U. S. Armed Forces will provide the scientists with logistical help.

It has been estimated that at the height of activity in Antarctica alone more than one thousand scientists and technicians will be wandering the frozen southland, working out from 33 separate stations. At least five or six of these bases will be established by American parties.

The Weddell Sea party—scientists, technicians, and a group of Seabees—sailed from Davisville, R. I. on Nov. 9 in two Navy vessels, an ice breaker and a freighter. After passage through the Panama Canal, down the west coast of South America, and through the Straits of Magellan, the two ships traveled eastward for hundreds of miles to avoid ice packs, before reaching the Weddell Sea coast.

The expedition is armed for what lies ahead with some of the nation's top minds, an immense amount of equipment and supplies, and an exhaustive lot of briefings on how and what to do. These last were conducted in October in Washington, D. C. and included briefings on: geology and collection of rock and botanical specimens, conducted by the U. S. Geological Survey; on surveying with the Kern and Wild theodolites, by the U. S. Coast and Geodetic Survey; on methods of collecting snow samples, by the U. S. Atomic Energy Commission; on use of the gyro-compass, by the Sperry Gyroscope Company; on previous polar expeditions and logistic problems, by U. S. Navy and Air Force; lectures by leading scientists in the various special fields; and instructions for safety precautions and care of frostbite.

At the end of the sessions, each man was issued the quantities of light but warm, especially designed clothing which were deemed sufficient for the long, frigid months ahead.

WHAT ARE SOME OF THE IMPORTANT FACTORS TO CONSIDER IN A PROGRAM OF IDENTIFYING THE GIFTED PUPIL IN MATHEMATICS AND SCIENCE?

MONTE S. NORTON
Whittier Junior High, Lincoln, Neb.

If a school desires an optimum program for the gifted pupil in mathematics and science, it must place a premium upon proper methods of identifying the gifted pupil. In many instances, school personnel are not aware of the tools available for valid identification while others use inadequate methods which frequently produce invalid results. Teachers and administrators appear to be in need of a comprehensive report concerning the latest techniques, instruments, and methods for identifying future scientists and mathematicians. This article is an accumulation of the latest thinking of authorities in the field in regard to important considerations schools should make in administering an identification program in science and mathematics.

Many definitions of the gifted pupil have been stated:

The gifted—any child whose performance in a potentially valuable line of human endeavor is consistently superior—The American Association for Gifted Children

The top one per cent of the juvenile population in general intelligence—Leta S. Hollingsworth

One who shows exceptionally high degree of ability to work with ideas—R. L. Thorndike

A child whose performance in a worthwhile type of human endeavor is consistently remarkable—Paul Witty

The gifted child is one who shows to an exceptionally high degree the ability to work with ideas. He is exceptionally capable in thinking, that is, in the manipulation and creation of abstractions of work and number—Howard F. Fehr

The really important child in the schools . . . is the boy or girl who is decidedly quicker, brighter, and surer than the average—E. P. Cubberley

The term "gifted child" refers to a child of high intelligence quotient—Arch O. Heck

The gifted pupils are the rapid learners in academic subjects. . . . They are the pupils in the upper 20% in general intelligence whose abilities lend themselves readily to intellectual pursuits—U. S. Dept. of Health, Education, and Welfare.

As shown by the definitions above, the term, gifted, is not a precise one. When describing the gifted child in terms of an I.Q. score, again there are varying opinions. There appears to be no set score for minimum ability. Some schools use 120 as a minimum I.Q. and thereby include many more pupils than other schools who favor scores of 135 or 140.

In each case, defining the lower limit of intellectual giftedness was arbitrary,

as is true in any situation in which a line of demarcation is set. The question immediately arises as to whether a child of 139 I.Q. is not gifted if another who has an I.Q. of 140 is. The question of where giftedness begins on a test score is highly debatable.[1]

The terms above-average and giftedness are not precise ones. If we think in terms of I.Q.'s, a child of an I.Q. of 115 or above will be roughly speaking, in the top 16% ($\frac{1}{6}$) of the population. Giftedness has frequently been thought of in terms of I.Q.'s above 130, although some writers have used a higher and some a lower point. Most writers would include in the group gifted not over 5% of the population, and some would limit it to 3% or even 1%. . . . All agree that evidence of superior mentality while including intelligence as measured by tests, is not to be thought of in terms of tests alone.[2]

Other standardized tests which include tests of knowledge, verbal comprehension, mechanical ability, abstract reasoning, spatial visualization and interests are also valuable means of identifying the gifted pupil in science and mathematics. Many such tests are readily available and can be of great help to the school. Tests or inventories in reading, special aptitudes, social maturity, personality, general scholastic achievement, and other pertinent areas which would help in the identification and future guidance of the pupil should also be administered by the school. All of the administered tests should be analyzed and recorded in order to obtain a complete profile of the student.

Although teachers' judgments are of value in identifying the gifted pupil in mathematics and science, there are certain precautions that should be taken into consideration when using teachers' recommendations. The following precautions are ones suggested by the Educational Service Bureau of the University of Pennsylvania:

1. There is a tendency to over-rate conformity as a mark of superiority.
2. There is a tendency to confuse school achievement with intelligence.
3. There is a tendency for teachers to become annoyed with pupils who manifest independent behavior, display marked curiosity and seek other ways of doing things.
4. There is a tendency for gifted learners to hide their talents rather than be considered a "brain" by their classmates.
5. Teachers often confuse chronological maturation with native ability.[3]

Although there are weaknesses in the use of teachers' judgments in identifying gifted pupils, teachers' opinions can be of great value in any identification program. Administrators and teachers can improve their judgments in gifted pupil identification by learning more about the important factors that indicate ability in mathematics or science. One technique that has proved valuable in the improvement of teachers' judgments is the "follow-up" plan. In this plan, teachers

[1] Marian Scheifele, *The Gifted Child in the Regular Classroom*, Bureau of Publications, Columbia University, 1953, p. 2.

[2] D. A. Worcester, *The Education of Children of Above-Average Mentality*, University of Nebraska Press, 1955, pp. 3 and 4.

[3] Educational Service Bureau, *Guiding Your Gifted*, University of Pennsylvania, 1954, pp. 2 and 3.

keep anecdotal records of their judgments and follow through for several years the children on whom they have made judgments. In this manner, teachers are able to analyze strengths and weaknesses in their own methods of identification and can improve and strengthen their abilites for identifying giftedness.

Teachers have found the following criteria helpful in selecting gifted students in mathematics:

1. Extraordinary memory seems to indicate a capacity for superior learning. A boy in the senior high school who could give at sight the square of any number between 1 and 100 is an example of a person having such a memory.
2. Intellectual curiosity is often indicated by a persistence in asking questions and an eagerness to investigate marginal content.
3. Ability to do abstract thinking may be revealed by unusual insight into probable discrepancies and by skill in formulating hypothesis from new data.
4. Ability to apply knowledge to other situations.
5. Persistence in worth-while behavior. A scientist or mathematician must not give up. This type of perseverance should not be confused with aimless prodding.
6. Insight into abstractions is found to an extraordinary extent in the scientist and mathematician. Many teachers have students in their classes who always seem to see the answer before the problem is completely stated.[4]

If used in conjunction with other criteria of identification, the cumulative record may also be of value in helping identify the gifted pupil in science and mathematics. Contents of the record folder of a pupil should include I.Q. scores; profile chart; detailed school record; anecdotal records made by teachers, parents and other community members; social history; special abilities; interests; special out-of-school activities; test results in such areas as mathematics, English, space perception, general aptitude, and others pertinent to the make-up of the individual. Frequently, a thorough study of the cumulative record will reveal clues useful in identifying the gifted pupil which may otherwise be overlooked.

The U. S. Department of Health, Education, and Welfare states that in addition to mental identification, other areas which may be of help in the identification of the gifted pupil are: (a) Physical development (b) Social and emotional growth (c) Moral character. This department is careful to point out that all gifted pupils do not necessarily possess each of these qualities nor are these characteristics ones of only the gifted pupil. As a group, however, the gifted generally tend to have these characteristics:

Physical Development

Physically, the gifted child in relation to other children, tends to:

1. Be slightly heavier and taller and to be heavier in relation to height.

[4] U. S. Department of Health, Education, and Welfare, *Education for the Talented in Mathematics and Science*. Bulletin 1952, No. 15, Washington, D. C., p. 5.

2. Be somewhat healthier and stronger; be well nourished.
3. Be relatively free from nervous disorders.
4. Be a little more advanced in ossification of bones.
5. Reach maturity at an earlier age.
6. Not to be overworked if the work suits his interests, ability, and if it is not permitted to interfere with regular hours of exercise and sleep.

Social and Emotional Growth

Socially and Emotionally the gifted pupil tends to:

1. Show superiority in desirable personality traits; to be more courteous, cooperative, obedient, willing to take suggestions; be better able to go along with others and have a keener sense of humor.
2. Possess a superior power of self-criticism.
3. Exhibit greater trustworthiness when under temptation to cheat.
4. Show less inclination to boast or overstate his knowledge.
5. Receive more opportunities as leader, up to 150 I.Q.; beyond that point to have preferences that reveal a level of interest two or three years beyond his age norm.
6. Show a greater preference for games involving rules and systems—complicated games require thinking.
7. Show a greater preference for games that are relatively quiet.
8. Enjoy the same outdoor games which are preferred by average children.
9. Create more imaginary playmates, in the case of the younger child.
10. Prefer playmates older than himself, children of his own mental age.[5]

Moral Character

According to recent studies, most gifted boys and girls seem to stand above the average with respect to moral qualities. They ordinarily have a keen sense of responsibility and an obligation to other people, a strong will power and resistance, and a modest outlook in regard to their own potentials, abilities, and accomplishments.

Marian Scheifele in her book, *The Gifted Child in the Regular Classroom*, lists the following reading interests preferred by by the gifted child:

1. Science, History, Biography, folk tales, informative fiction, poetry, drama, (Less interested in adventure, mystery, and emotional fiction than exists among other children).
2. Encyclopedias, dictionaries, and other compilations of classified information.
3. As a group, gifted children soon outgrow children's literature and frequently turn to adult books and magazines. Their interests in comics declines earlier than that of their classmates.

Marian Scheifele lists the following hobbies as those preferred by gifted children:

1. Collecting (More collections of scientific interests—shells, insects, minerals, coins etc. . . .)
2. Reading.
3. Dramatics.
4. Playing musical instruments.
5. Religious activity.

[5] Marian Scheifele, *op. cit.*, p. 6

6. Scouting.
7. Debating.
8. Student of ancient history.[6]

The following checklist may be of value to the teacher and administrator in the identification of the pupil who is gifted in mathematics or science. As mentioned earlier, it must be remembered that the characteristics should be thought in of terms of the degree to which the pupil possesses these traits rather than possession alone.

I. Physical Traits of the Gifted Pupil

( ) 1. Tend to be healthier, better developed physically, and are taller and heavier than the average.
( ) 2. Become tired less readily.
( ) 3. Reach maturity earlier than do the average.
( ) 4. Dislike monotonous tasks; like variety.
( ) 5. Prefer somewhat more quiet games and activities than do the average.

II. Mental Traits of the Gifted Pupil

( ) 1. Show intellectual superiority.
( ) 2. Are extremely apt in using a wide vocabulary.
( ) 3. Have a variety of interests.
( ) 4. Learn much faster and retain more of what they have learned than do the average.
( ) 5. Are able to work surprisingly well with ideas and abstractions.
( ) 6. Have extraordinary memories.
( ) 7. Are well versed in a variety of fields—These fields may include many not necessarily offered by the school.
( ) 8. Use keen systems for analyzing and solving problems.
( ) 9. Are more capable of self-evaluation and self-criticism than the average.
( ) 10. Possess a well-developed ability to organize and execute their own plans, etc.; use more initiative.
( ) 11. Have extraordinary memories.
( ) 12. Are more capable of seeing and using their knowledge in practical situations and to solve practical problems.
( ) 13. Possess keen senses of insight.
( ) 14. Are usually quicker to accept a "challenge."
( ) 15. Can think logically in problem-solving situations.

III. Social and Emotional Traits of the Gifted Pupil

( ) 1. Prefer games and activities in which thinking is required.
( ) 2. Are generally well-behaved.
( ) 3. Adjust more easily to new situations than do the average.
( ) 4. Prefer the company of those of the same mental age as themselves.
( ) 5. Possess more necessary qualities for leadership than do the average.
( ) 6. Are high in moral standards.
( ) 7. Are relatively modest about their own abilities and achievements.
( ) 8. Possess a strong desire for acceptance in some social group.
( ) 9. Are not necessarily more free from problems than the average, but seem more ready to accept and to solve problems encountered.
( ) 10. Tend to enjoy activities that are remote from group activities.

Giftedness appears in many different forms in every cultural group and at every level of society. It is the source of power which has contributed most to

[6] *Ibid*, pp. 7 and 9.

progress at all times and in all places. Yet, like other human resources, it remains a potentiality until it has been discovered and developed.[7]

American society needs the most capable people as its leaders. Public schools and other educational institutions can do much to meet this need by providing the best possible programs for the optimum development of all talented youth. An adequate program of identification is an important part of any gifted pupil program, for without valid identifications the entire program would be operating in a vacuum. Educational institutions, without the interest and assistance of the American people are almost helpless. To provide the education that gifted pupils should have, financial assistance as well as a genuine appreciation for able leaders is needed. Educators, parents, and all other Americans should develop a keen awareness of the present problems that now exist in the education of the gifted pupil. Discovering talented people in mathematics and science is the responsibility of parents, teachers, school administrators, community members, and everyone who is concerned about the future of our youth and our nation.

The methods of identifying gifted pupils now in use serve a very important purpose, but they need to be refined, improved and more generally applied. We must reinterpret some of our older convictions in the light of fundamental new principles of child growth and development.[8]

Accurate identification of all varieties of giftedness is of such importance in the conservation and development of human talent that great efforts should be made to increase the quantity of research into this problem. However, the improvement of educational practices need not wait on the completion of further research. Greater use of what we already know is the immediate need and the attainable end, if the current extent of talent waste is to be reduced.[9]

[7] American Association for Gifted Children, *The Gifted Child*, edited by Paul Witty, D. C. Heath and Co., Boston, 1951, pp. 11 and 18.

[8] *Ibid*, pp. 11 and 18.

[9] Educational Policies Commission, *Education of the Gifted*, National Education Association of the U. S., Washington, D. C., June, 1950, p. 48.

CHEMISTRY PRIZES AT CARNEGIE TECH

The winners of the 1956–57 Warner Prize in Chemistry were announced by Dr. Frederick D. Rossini, Head of the Department of Chemistry at Carnegie Institute of Technology.

The Warner Sophomore Prize went to John A. Olmsted, III of Petaluma, California and the Warner Senior Prize to Terry E. Sharp of LaCrosse, Wisconsin.

The prizes were established by Dr. J. C. Warner, President of Carnegie Tech and former Head of the Department of Chemistry. The prize for sophomores consists of a three-year membership in the Student Affiliate Chapter of the American Chemical Society and is awarded on the basis of scholastic record. The prize for seniors is a three-year membership to the ACS and is given for both scholastic achievement and professional promise.

HYBRIDIZATION IN POULTRY BREEDING*

E. E. SCHNETZLER
DeKalb Hybrid Seed Co., DeKalb, Illinois

Hybridization is a phenomenon of genetics that has meant much to American agriculture. There is no other single discovery in the field of applied genetics that has brought an equivalent in economic gain. Even with its importance and wide use, the phenomenon is not well understood. Its use has met with outstanding success in several fields of agriculture but it has been the application of a specific method that has brought results without a full understanding of the genetics involved.

Peculiar to the phenomenon is the fact that the hybrid outperforms either parent from which it comes. It functions more effectively for a longer period of time and with greater physiological efficiency. It exhibits heterosis in increased vigor, size, reproduction, and resistance to disease and insects. The results are manifested as the specific function of the unlikeness of the genetic make-up of the germ plasm of the individuals crossed, the amount of unlikeness determining the degree of heterosis obtained.

The use of hybridization has been practiced in both plant and animal breeding. First generation crosses of some horticultural plants, such as tomatoes, onions, egg plant, cucumbers, and especially sweet corn, have been grown extensively by home and truck growers. Some farm crops, such as tobacco, sugar beets, forage crops, and sorghum have been improved tremendously by applying this principle. However, the success with these plants does not nearly equal that which has been obtained by the improvement and promotion in the breeding of hybrid corn which now represents nearly all of the corn planted in this country.

During World War II hybridization of corn was emphatic and tremendous in supplying food to the American people. Its unveiling and the full realization could not have come at a more opportune time. From 1941 to 1944 the American farmer was able to produce four record breaking corn crops of 3 billion bushels. During World War I, before hybrid corn, the American farmers produced one 3 billion bushel corn crop from 110 million acres of land. During the last World War, with hybrid corn, he produced the same number of bushels from 21 million less acres. The land saved was available for other war crops and the labor for factories in the manufacturing of

* Presented at the Biology Section of the Central Association of Science and Mathematics Teachers, Chicago, Nov. 23, 1956.

war materials. An evaluation of such increased efficiency is impossible to measure.

The history of hybrid corn is a real scientific story. It must suffice to point out here that the development was mainly in the hands of approximately a dozen men with no individual being more responsible than another. One of the very first to give serious planned thoughts to corn improvement was that of Professor Cyril G. Hopkins of Illinois who had the idea of altering the chemistry of a kernel of corn to make it a better feed for livestock. His plan was to improve the oil and protein content. To do this he devised a new corn breeding technic which is known as the "Illinois ear-to-row" method, which made him the first corn breeder to employ the pedigree technique. Since he was working with small groups he was forced to do some inbreeding. It was from observations of this experiment that Hopkins' associate, Edward Murray East, got the idea of making a detailed study of inbreeding of corn and developed the first inbred lines. Later, after he had moved to Connecticut, he made the first single cross hybrids by crossing two of his best inbreds with a tremendous response in vigor and yield.

East continued his research but even though his discovery was outstanding he had to conclude that there was nothing of practical importance about corn hybrids from inbred lines. Because of the small yield of seed from the inbred parent, it could offer little toward improving corn on a large scale operation. However, Donald Jones, who had been employed by the Connecticut Experiment Station to work with East conceived the idea of using the seed from the first cross plant where good yields were obtained. If two single crosses could be put together and the same vigor and uniformity of yield retained as in the single cross there would be plenty of seed for all farmers. The next year his experiments confirmed this idea and the gate was open for the commercial production of hybrid corn on a large scale.

After the preliminary work of producing inbred lines, and the first crosses, and the discovery of the four-way cross, research work and improvements in the corn plant continued at a relatively rapid pace. Commercial companies entered the field of research and production along with the State Experiment Stations and the Federal Government. Their efforts soon made it possible for farmers throughout the country to plant hybrid seed corn, and today it is available to all farmers with improvements that seemed impossible before the era of hybridization.

The success of this breeding technique in the improvement of corn yields was a real challenge to animal breeders. The methods and the results could not be questioned. It seemed that here was a possibility for improvement but it could not be done with the pure-line method

of breeding which was being followed by animal breeders. Unless a pattern of breeding could be set up (resembling that of corn) the gains from this method of breeding could never be reached.

Two of the large companies in the business of producing hybrid corn were cognizant of the situation and set out to apply this principle to the breeding of poultry, the first work being done more than a decade ago. Here again the State Experiment Stations entered the field of research making studies of hybridization with both poultry and other animals. Drosophilia, the small fruit fly, was included in these studies, which because of its short generation time made it possible to receive some basic information in much less time than with farm animals. As a result hybrid poultry and swine have joined the corn industry and have today become an important part of American agriculture.

Realization of the full benefits of hybridization requires the crossing of unlike genetic entities (inbred lines). In the production of corn these were produced by several selfings of selected plants (placing the pollen of a plant on its own ovules). In poultry, inbreeding is done by mating close relatives, for instance brothers and sisters. The early experiments with inbreeding chickens, before the era of hybridization, showed that the production characteristics were so greatly reduced that the inbred lines were difficult to retain with many of them being lost because no individuals were able to survive until the next breeding season. This was a a great problem facing those who were contemplating the production of hybrid poultry. To be of economic value to the industry it was known that the lines must be sufficiently reproductive to carry themselves and also produce sufficient first crosses for the production of commercial chicks to earn a profit and carry the overhead of research and the production operations.

Research soon eliminated this stumbling block. It was found that inbreeding uncovered many defects and deformities within the lines and there was a loss of vigor and production which made it essential to eliminate 90% of the lines started, but of the 10% left there were some lines that could withstand the rigors of inbreeding and retain fair hatchability, egg size, production and livability. These selected lines became the nucleus around which the breeder built his breeding program. He assumed in the beginning that he could not rely on the production of the inbred but a single cross female would have to be used to produce the hatching eggs if this type of breeding were to supply many poultrymen with chicks.

As in corn this meant that many inbred lines had to be produced; and many single and four way crosses tested to find the combination that yielded the vigor and the production desired. Many inbred lines are tested in thousands of crosses each year by a single corn breeder.

Even though it is just as essential to have these large numbers with chickens it had to be reduced to hundreds simply because testing facilities could not be made available. This has meant that the breeders using this breeding technique needed much more volume than most of them had used with the standard pure line method; and that the production of hybrid chicks had to be confined to a few breeders with the facilities to do the job.

During the past two decades research in poultry breeding had solved many of the problems, and hybridization has become a practical tool for the poultry breeder. The genetic gains which could not be made with the pure line method have now been made and passed on to the chick buyer.

What does this mean to the poultry industry? This has meant that the chick buyer now has chicks available with more inherent vigor with the ability to withstand more adverse environment and perform better under more varied conditions than those of the pure lines. Gains have been made in such important traits as hatchability 5 to 10%; egg production 10%; livability 5 to 10%; and feed efficiency 10 to 15%. From the 900 million chicks produced annually in U. S. with an increase of five chicks per 100 eggs set; fifteen to twenty eggs more per laying pullet; five to ten more pullets out of each 100 alive to produce eggs; and 10 to 15% greater feed efficiency per dozen eggs, a large saving can be made to the poultrymen in furnishing our Nation's egg supply. Dollar for dollar hybridization has the potential of meaning much more to the American poultry industry than it has to corn.

This last season there were approximately 80 million hybrid chicks made available to chick buyers. This number has grown steadily for the past ten years, and more will be made available as the breeders make the provision necessary for the commercial production of this type of chick. An important feature of this type of breeding is that it has as its foundation four inbred lines. Millions of chicks can be produced from these time after time knowing the combination of these will give the same appearance and performance. Research will continue to bring improvements through improved crosses and through studies leading to ways of improving selection for superior genotypes. This program has followed the pattern of corn and the results obtained from it must be given the credit for giving the animal breeder the courage to apply this system. It has all meant that the poultry industry will be able to "produce more for less" and will more efficiently supply food for the American people.

ATTITUDES IN THE MATHEMATICS CLASSROOM

DONOVAN A. JOHNSON
University of Minnesota High School, Minneapolis, Minn.

In our concern for improving the mathematics curriculum and increasing enrollment in mathematics, have we forgotten a crucial factor, namely attitudes? Have we forgotten that learning involves emotional vectors such as attitudes? It is the attitudes that our students develop which are likely to stimulate or to stop further study of mathematics. It is the attitudes which we build that are highly involved in the learning and retention of our subject. It is the attitudes which we teach that are the most important factors in the activities in which our youth participate—now and later. And it is often the attitudes *you* have built that are the basis for your rank as a succesful or unsuccessful teacher.

One unique aspect about teaching attitudes is that we have no choice in the matter. No matter what subject we are teaching or what method we are using many concomitant learnings and changes in attitudes are taking place. While teaching how to solve equations, our students may also be learning to dodge responsibility, to be cooperative, to cheat, to be loyal to the class, to dislike mathematics, to appreciate the power of mathematics, to lose respect for the teacher or to build confidence through checking.

We have no escape—attitudes will inevitably be learned by the poor achiever as well as by the superior student. Every hour spent in the classroom results in developing attitudes, desirable or undesirable. Thus, if we are to provide a wholesome classroom situation that builds desirable attitudes, ideals and habits, we need to consider what factors are involved in developing these "feelings" or emotional aspects of learning.

First, let us consider the attitudes toward mathematics which we would like to foster in our mathematics classroom. Most of us would probably agree to include the following:

Appreciation of mathematics as an important factor in the development of our society and in our daily lives.
Desire and interest in learning mathematics.
Interest in and curiosity about the unique structure of mathematics.
Confidence in and loyalty to mathematics, the mathematics teacher, and fellow classmates.
Respect for the achievement of mathematical competence by colleagues.
Acceptance of responsibility for attaining competence for oneself and others.
Willingness to spend time, energy, attention to build insight, creativity, discovery beyond the requirements of the course.
Awareness that an understanding of the structure and spirit of mathematics will enable one to think critically and reserve judgment.

In addition to these specific attitudes we, of course, have responsibility for teaching a great number of general attitudes such as respect for the rights of individuals.

Attitudes are not easy to define. They are very similar to ideals and habits, but they have more "feeling," more emotional accompaniments. Attitudes extend beyond the range of habits; they govern widely the *use* of knowledge. Attitudes differ from ideals in that conscious purpose or foresight of the goal has dropped out. An attitude is usually defined as an enduring emotional set or predisposition to react in a characteristic way toward a given person, object, idea, or situation. In this paper we will consider attitudes to include likes, appreciations, prejudices, interests, dispositions and opinions.

What then are the characteristics of the attitudes we wish to nourish? An attitude involves an emotional response as a component. For example, appreciation of mathematics has an intellectual aspect but action depends on emotion. You must enjoy mathematics if you are really going to read voluntarily a mathematics book. If you think mathematics is important, it will hurt when someone says "Take German next year instead of mathematics." The student who appreciates the order and logic of mathematics will get satisfaction out of an elegant proof.

An attitude results in a habitual tendency to respond in a certain way to certain stimuli. The person who found mathematics to lack practical application in a geometry class is likely to consider all mathematics formal and impractical.

An attitude has wide applicability to many related situations. The student who has been successful in learning his mathematics through an inductive-discovery approach probably will tend to approach nonmathematical problems with a confident, inquiring attitude.

An attitude involves a response that tends to remain stable and constant. The pupil who dislikes arithmetic because he is not successful in it will likely avoid any further contact with it. You may be able to change his attitude but it usually requires an intense or long experience to do so.

If the attitude of appreciation of mathematics is attained by a student, then he studies mathematics because he enjoys it, he gets satisfaction from knowing mathematical ideas; he feels rewarded when he attains mathematical competency. Attaining this emotional component is not easy because we cannot force this emotional response. At the same time we want to base the attitude on sound information without too much emotion. We can furnish material, require reading, ask for responses but we cannot compel the student to enjoy mathematics.

How do the attitudes of our students grow? Likes, aversions, in-

terests, antagonism, are often traceable to some strong emotional experience or to incidents or associations of a definitely pleasant or unpleasant nature. Humiliation or unjust treatment sets up resentments. A timid attitude results from fright. An appreciative attitude develops from enjoyment. This association is a strong indication that conditioning is the explanation of how attitudes develop. However, we usually do not discriminate in our likes and dislikes between a person and his deeds. Thus high school students usually say that the subjects they like best are the ones taught by the best-liked teachers. Some examples of experiences that are often effective as attitude builders are the following:

1. *Imitation:*—Many times we simply adopt the attitudes of our associates. This is often the case in religious attitudes, political opinion, and preferences for food, music, or mathematics. The adolescent is inclined to conform to his group. He notices their likes and dislikes and tends to copy them in order to be like the others. Likewise, he may imitate a teacher for whom he has a high regard.

2. *Informative Experience:*—By hearing, seeing, or reading about the role of mathematics, we may develop an appreciation of it. For example, learning about the contribution of mathematics in art or music or science should make us more appreciative of the power of mathematics. Discussing current news about modern computing machines or the use of sets to solve political problems brings mathematics closer to the lives of our students.

3. *Deliberate Cultivations:*—Sometimes it is possible to cultivate an attitude such as appreciation *deliberately*. We may discuss with our students why mathematics is important, how we can become more successful in learning it and what the teacher or students can do to make the course more enjoyable. Again the success of this method depends on the extent that it is a favorable emotional experience.

How then do we build the attitudes we want our students to have? We have all been involved in studying and applying in our classrooms a variety of techniques of teaching. We have read books and articles that have suggested a variety of methods and materials to help us build mathematical competence on the part of our students. However, very little has been said about how to teach the attitudes that are important for continued progress in the subject. Recent methods textbooks devote approximately two pages each to the teaching of attitudes and appreciation. Either we know too little about how to teach attitudes or else we have not accepted the responsibility very seriously.

As we know, many attitudes are well developed before the student enters our classroom. He has often learned from his parents, friends, teachers, or personal experiences many attitudes about mathematics.

These attitudes may be desirable but often are the reverse. Thus, it is important that we be sensitive to the attitude possessed by our students, strive to modify established attitudes that are undesirable and to engender desirable new ones.

The development of attitudes is such an important aspect of our teaching that it should be cultivated by design. We dare not trust hazards of growth in proper attitudes as an incidental by-product of classroom instruction. Since we learn according to our reactions to experiences, we cannot expect an attitude of appreciation to emerge from classroom lessons that are dull and uninspiring or from homework that is meaningless drudgery. If our students are to learn to like mathematics, they must find pleasure in performing the learning activities in and out of the mathematics classroom. And our students will find pleasure in doing that which they can do successfully, that which seems significant in meeting their needs, that which gives them status with those they esteem.

Because the teaching of attitudes is so nebulous, it is difficult to spell out definite procedures.

1. The first basic principle seems to be that we are likely to teach only those attitudes which we ourselves possess. This means that we must be aware of the attitudes we wish to teach and cultivate them for ourselves. Then our speech, action and assignments must exemplify the attitudes we teach. The familiar quotation "What you are speaks so loudly I cannot hear what you say" gives the reason in a nutshell. This is due to the fact that we teach attitudes indirectly, that is, by osmosis. If our attitude concentration is only equal to or less than that of the student, no transmission takes place. Your appreciation of mathematics as an important, dynamic, remarkable subject must be real and deep. Your attitude toward students must be sympathetic and understanding.

The acceptance of your attitude as a teacher is directly related to the esteem your students have for you. As a teacher you automatically have prestige especially at the elementary and junior high school level. At a more advanced level you will need to build confidence and acceptance on the part of your students to the point where they will adopt your attitudes. A spirit of loyalty, security, and enjoyment in your classroom is indispensable. You should make your students feel that your attitude will still be friendly regardless of the success or failure of their efforts.

2. But the teachers' attitudes do not of themselves insure the adoption of his attitude by his pupils. You will need to use both direct and incidental instruction. Many of the attitudes toward mathematics may be enhanced by understandings. We need to enrich our instruction because what one enjoys is determined in a large measure by our

training and experience. Information about the mathematics around us, the structure of mathematics, the varied fields of mathematics are basic to an appreciation of it. Thus, as we teach the nature of mathematics, we must dramatize its unusual properties, its precision, its logic. To add the needed *emotional tone* to the attitude requires sincere enthusiasm on the part of the teacher. Many important influences are small things such as the inflection of your voice, a glance, or a silence. The subtleties of the way you say something, the way you act, the way you look are keys to the emotional tone of what you say. Even in an incidental or indirect approach, the presentation needs careful planning. It is also appropriate to point out to the student the importance of his developing certain attitudes and interests. However, mere awe of the power of mathematics or of its unique structure does not necessarily mean appreciation of it. Deep appreciation is based on understanding but also involves a pleasurable emotion. To attain this response we need a classroom atmosphere that reflects enthusiasm, interest, mental activity, delight in learning. An attractive classroom with varied books, displays, models, will add to the proper setting for this learning.

3. Besides planned learning activities, a good teacher of attitudes uses appropriate material at the appropriate time. Unusual topics such as space, infinity, paradoxes, number relations, proof of $2\times2=4$ presented in a striking manner, may stimulate latent curiosity. At the same time we must be sure that the material is within the range of the students' understanding since attitudes are energized largely by the individual's need for security and the esteem of others. Often relating the topic to some school event or student interest will provide an appropriate setting.

4. The student must be provided with an opportunity to apply and extend his aroused interest. Reading books, building models, attending club meetings, or conferring with the teacher may be means for participating in further activities. Through satisfying activities over an extended period, the attitude will build to sufficient intensity so that it will be applied generally.

5. Some writers indicate that the use of slogans or quotations, may be influential in attitude formation. To be effective these slogans must be made by accepted authorities and in acceptable language. This is because knowledge of an ideal is effective in changing behavior only when the ideal is accepted as desirable. The critical factor is the adoption of the standard of conduct or achievement as a goal by the students. To secure this the student must truly appreciate its value. An appeal to personal concern is usually more effective than mottos, slogans, or admonition. An example is more convincing than logical argument.

If we are concerned about the teaching of attitudes, we will need to have some idea of the progress we are making in developing these attitudes. Thus we need to find ways of measuring changes in attitudes.

How does a student perform who has attained certain attitudes? The conversation, the written work, the activities of the student both in and out of the classroom will be indicative of the individual's attitudes. In his conversation he will express opinions, he will reveal his thinking, he will show his interests and appreciations. His participation in class discussions will indicate his awareness of mathematics in science, at home, in sports. He will discuss his mathematics outside the classroom with fellow students, other teachers, and friends. He will encourage his friends in their effort to be successful.

In his written work attitudes are shown for example by the pride taken in completing work, by doing extra work by searching for the most elegant exposition or solution, and by the effort used to discover new relationships, new forms, new procedures.

In his activities he may find unique problems or applications to bring to class, he may participate in a mathematics club, he may volunteer to bring materials to class or to gather material on an optional topic, he may read mathematics books, he may keep a mathematics notebook or scrapbook, he may use ingenuity to create original models, he may be active in committee work, *and he will do these things cheerfully*. He will be annoyed by distractions that hinder his progress or that violate good mathematics.

Thus, the student with the proper attitudes will enter wholeheartedly into the learning activities because he is sensitive to mathematics wherever he finds it and derives pleasure from his contacts with it. If the attitudes are only partially developed he will particpate in some situations and not in others.

Besides evaluating attitudes by anecdotal records of behavior and expressed opinion, we may use a rating scale. Rating scales have been developed so that attitudes can be appraised more objectively and definitely. These scales are a means of converting responses to a quantitative basis. In one type a question is asked and for each question a list of possible answers is presented. The answers are arranged to represent different degrees of approval or disapproval, favorableness or unfavorableness toward the proposition or issue to which the question refers. They are presumed to represent the students' feelings, opinions, or most probable way of reacting to the ideas or situation presented. Statements may vary from extremely unfavorable to extremely favorable. These scales are based on the assumption that differences in attitudes toward a given matter lie on a continuum

between two opposite extremes. Thus, these scales locate the degree of approval or disapproval and reveal shifts in attitudes. These scales, of course, assume that the subject's expressed opinion is a reliable expression of his actual attitude. This may not necessarily be a true assumption. The following are scales that have been used with some success in mathematics classes:

ATTITUDE INVENTORY

This check list is intended to help us discover what you think about mathematics. Check each statement truthfully and thoughtfully so that the best kind of course can be planned for you and for those who follow you. Use the following code in describing your thinking with respect to the item.

Agree—A Undecided—U Disagree—D

_____ 1. Mathematics is my most difficult course.

_____ 2. This year mathematics is my favorite subject.

_____ 3. If a friend asked me about this course, I would tell him to be sure to take it.

_____ 4. I would like school better if I didn't take mathematics.

_____ 5. One of the things I like best about mathematics is its logic and precision.

_____ 6. One reason I am taking this course is because it is required for college entrance.

_____ 7. Mathematics is not as important a part of our culture as music or art.

_____ 8. This course is the most valuable course I am taking this year.

_____ 9. If I get a wrong answer, I like to find my own mistake.

_____10. Mathematics gives me a chance to do independent work.

_____11. I would like mathematics better if it were more practical.

_____12. One reason I like mathematics is because it is so different from my other subjects.

_____13. This course has made me curious about many new ideas.

_____14. Most of my work in this class is done to get a good grade rather than to learn the subject.

_____15. Mathematics projects give me a chance to do creative, original work.

_____16. One of the things I like about mathematics is that its difficulty is a challenge to me.

_____17. I enjoy solving a mathematical problem as much as solving any puzzle.

_____18. My mathematics teacher seems to like this class.

Too often our teaching of mathematics has missed its mark and has left the student with a dislike for mathematics rather than an appreciation of the subject. When your students leave your classroom, are they glad they have spent the period with you or do they say, "Aw, all we do in math is work foolish problems"? Do your students want to study mathematics more after being in your classroom a year than before they started? Do they say, "I think math is my most important subject"? It is likely that the greatest residue of our instruction is the attitudes were have nurtured. It is these attitudes which are likely to influence retention, stimulate further study, and interest others in the study of mathematics. And if the right attitudes aren't growing in our classrooms, we need to do something about it.

SEARCH FOR PH.D'S IN SCIENCE

Industry has again widened the scope of its hunt for engineering graduates. Figures released recently from the Carnegie Institute of Technology Bureau of Placements indicates a marked trend on the part of industry into the field of recruiting Ph.D. candidates, apart from M.S. and B.S.

This drive for engineers in the Ph.D. field is accompanied by a significant rise in the number of students entering the graduate field of study. With the consistent shortage of engineering students and the increasing number of students entering graduate studies the companies have not only been forced to recruit harder and longer but at a new and higher level.

Last year, at Carnegie Tech, only 40 companies sent interviewers to the campus to discuss career opportunities with graduate students. This year more than 70 major companies—in all industrial classifications—have arranged for student-company representative interviews. The interviews with the graduate students have already begun and will continue through the year. Since the type of interviewer for graduate students is considerably different than for B.S. students the companies will, this year, make two trips to the campus.

Due to the advanced education of the Ph.D. candidate and his desire to specialize in a particular phase of his field the complexion of the interviews and the type of recruiter is of marked difference from the B.S. interviewer. The companies recruiting for Ph.D. candidates are sending technical men—such as research directors or heads of research projects rather than the usual personnel men from the administrative departments.

DOES HIGHER EDUCATION PAY?

A Bachelor's degree in science or engineering is the least a boy should have, and a Master's degree is better.

Anyone thinking of basic research in physics or chemistry should go on to get a Ph.D. It's a virtual necessity for landing a good job in government, industry, or the academic world. Besides, it brings a better salary.

Just recently, a study was made to compute how much more money a scientist with a Ph.D. was likely to earn during the course of his life than one with a Bachelor's degree.

It came to $100,000.

—L. R. HAFSTAD, *Vice-President of General Motors*

INTEGRATION OF ARITHMETIC WITH SCIENCE THROUGH THE STUDY OF WEATHER IN THE ELEMENTARY SCHOOL*

M. IRA DUBINS
The School of Education, Northwestern University, Evanston, Illinois

Mathematics and science go hand in hand. Mathematics is the tool of science. Lord Kelvin, a great scientist, said, "When you can measure what you are speaking about, and express it in numbers, you know something about it, but when you cannot measure it, when you cannot express it in numbers your knowledge is of a meager and unsatisfactory kind." In his history of physics[1] Lloyd Taylor stated:

> The point has been repeatedly emphasized that the principal strategy of the physical sciences is quantitative work; that is, mathematical formulation of theory accompanied by accurate measurements in the laboratory. The emphasis will continue. It is impossible to overdo it. It is the outstanding fact in the development of every phase of physics.
>
> In the history of mechanics, in heat, sound, and light, in magnetism and electricity, after the first rough qualitative blocking out of the field by the early explorers the subjects entered upon a period of sterility in every case until fertilized by quantitative methods.

The importance of mathematics has increased tremendously today because of the vital importance of science. There exists a shortage of trained mathematics teachers and mathematicians along with science teachers and scientists and engineers. One of the reasons is the failure of our young people to develop interests along these lines. In order to remedy the situation we must start as early as possible to kindle interests. We must make arithmetic more meaningful. I know of no better way of doing this than by bringing in more quantitative aspects of science which have hitherto been neglected and thereby integrating arithmetic and science in the elementary grades wherever possible. In this paper I will use one unit, that of weather, to show how this is possible.

I have selected weather as the topic for integration of arithmetic with science for several reasons. According to a study I made a few years ago[2] this is the most widely taught of the sub-areas of science in the elementary school. It, undoubtedly, is the most common topic of conversation. It is a vital part of our environment. It offers prolific examples, as you will see, where arithmetic can be tied in with science

* Presented at the Elementary School Group of the Central Association of Science and Mathematics Teachers, Saturday, November 24, 1956, Chicago, Illinois.

[1] L. W. Taylor, "Physics, The Pioneer Science," p. 643, Houghton Mifflin Co., Boston, 1941.

[2] M. I. Dubins, "Current Practices in Elementary School Science with Reference to Courses of Study Published from 1940–1952, and the Extent of Activities Undertaken for the Improvement of Instruction," unpublished doctorate dissertation, Boston University, 1953.

very easily and appropriately, where arithmetic can be made more meaningful, and where the understanding of science can be facilitated by the use of arithmetic.

In the study of weather much data is utilized. The temperature is taken, the sky cover, the type of clouds, the altitude of the clouds, the barometric pressure, the wind velocity, the wind direction, the dew point, the relative humidity, the visibility, the amount of precipitation, the type of precipitation, and the type of day—sunny and clear, partly cloudy, cloudy, and precipitation.

Not all of these data are available to teachers and students in the elementary school as they occur. However, the teacher and the pupils can, according to their grade level, keep their own records and secure additional data from newspapers, radio, television, local weather stations, and the United States Weather Bureau as the need arises. As a matter of fact the use of all the data would be unwise by all elementary grades, and use of exact data is unnecessary in the early elementary grades as will be shown shortly.

In order to have available some important, interesting, and useful data the teacher should order from the United States Weather Bureau Office in the nearest large city the *LOCAL CLIMATOLOGICAL DATA with Comparative Data* for the previous year for that city. This four page pamphlet sells for fifteen cents and one is printed annually for each United States locality where weather records are kept. If interested, one can get records for each month for one year and these are fifteen cents each, or $1.50 for the set of twelve. However, for purposes described in this paper the one pamphlet which has the annual summary is sufficient, more appropriate, and economical.

The annual summary contains a narrative climatological summary of the city. It has the exact latitude, longitude, and elevation above sea level of the weather station where the data was collected. It has the average daily maximum, average daily minimum, and average monthly temperature for each month of the year based on the records of the preceding thirty years. It has these data for the year which appears on the title page. The latest would be for 1955. Included are the amounts of precipitation, the relative humidity, the wind velocity, the percentage of possible sunshine, the average sky cover, the number of clear, partly cloudy, cloudy, and days during the month in which precipitation occurred. In addition there are the record maximum and record minimum temperatures, both daily and monthly, the normal and record monthly and record 24-hour precipitation totals, the normal and record monthly relative humidity, the normal number of different types of days by months, and the maximum number of days having precipitation. The extremes are based

on records extending back to the opening of the weather station whereas the averages are based on the previous thirty years of records. Also presented are the monthly average temperatures for each month of the preceding thirty years, the total monthly precipitation for each month of the same period, degree days, and the amount of snowfall.

Thus it can be seen that for fifteen cents (five years ago it was five cents) a wealth of information can be obtained. Now we will see how we can use these data in integrating arithmetic with science in the elementary school. The data I have mentioned will be most useful to teachers in grade four and higher. A most satisfactory source of data for the primary grades is that which appears in the daily newspapers. These data consist of hourly temperatures, maximum and minimum temperatures for the previous day, and the maximum and minimum temperatures for several of the cities of the United States.

I will now present suggestions for the integration of arithmetic with science by grade levels. As different school systems have different grade placement of arithmetic and science concepts it should be borne in mind that the grade presentation which follows can and should be modified according to local situation. The assignment of concepts to grade levels on my part is based on the curriculum of a few schools in the midwest and is for ease of presentation rather than best practices which do not apply here at this time.

GRADE 1

As soon as children learn to read numbers give them practice in reading a thermometer. "Making and Using Classroom Science Materials in the Elementary School" by Glenn Blough and Marjorie Campbell published by the Dryden Press in 1954 has on pages 116 and 117 a description of a dummy or ribbon thermometer. I would suggest making two large ones and labelling the degrees on one by 10's, and on the other by 5's.

You can tell the children the temperature outside and inside and ask them which is larger. You can tell them the temperature (maximum) in three cities as published in yesterday's newspaper and ask them to select the city where it was warmest. You can tell them the minimum temperatures in five different cities and ask them to choose the city which was the coldest of the five.

You can have the children record the outside temperature to the nearest five or ten degrees during the day and ask them at what time it was the coldest and at what time it was the warmest.

The teacher can construct a large calendar, say one two feet by four feet. Part of the space for each day can be ruled off and labelled sunny, partly cloudy, cloudy, rain-drizzle-snow. A check can be placed

in the appropriate block. A running record can be kept of the number of days of each type as the month proceeds. This will give the children an opportunity to count.

Grade 2

A metal can such as from coffee or peaches can serve as a rain gauge. An ordinary ruler completes the simple rain gauge which is suitable for the primary grades. Each time that there is precipitation the ruler is placed in the can and the amount measured to the nearest inch. Rarely will the amount of rain or melted snow be a whole number. The pupils can be told to record the number of inches to which the water level is the closest. At the second grade this is accurate enough. If there is snow its depth can be measured and then after it has melted its depth should be measured again. An important concept here is that snow is a form of water. Another concept is that water occupies less space than snow. Separate records should be kept for the amount of snow and the amount of rain. Let the children know that in obtaining the total amount of precipitation during the year the melted snow is counted as rain.

A ribbon thermometer (see first grade) with every other degree marked can be constructed. This will give the students in the second grade practice in reading thermometers to the nearest degree. They can also pactice on real thermometers. Show the children that when they touch the bulb of the thermometer with their finger the temperature starts to rise. The reason is that our body temperature is. higher than room or outdoor temperature almost all the time except in the hottest summer days. Here is an excellent opportunity to ask the children if the doctor has ever put a thermometer in their mouth. Ask them what the normal body temperature should be. It is 98.6 degrees Fahrenheit.

Practice in addition can be obtained by having the children keep cumulative records of the amount of precipitation over periods of one month, and then monthly totals. Practice in subtraction can be gotten by getting the difference between the temperatures a few hours apart. In most cases the answer will be less than ten. The teacher can have the children subtract the maximum temperature of one day from that of the previous day. The teacher can have the pupil subtract the maximum temperature of his city from that of another city on the same day. This can also be done for minimum temperatures. In each case the teacher can select data so that the problem will not be too difficult for the pupil and will not involve operations which the pupil has not yet had, such as borrowing. In addition the teacher can make up problems of a similar nature, although with all the data available in the daily newspapers this is not necessary.

During a snowstorm the outdoor temperature should be recorded by the teacher or pupils and the relationship between the temperature and the type of precipitation should be studied. Do not tell the pupils the answer. See if they can figure out from the data what the relationship is. At times there will be snow falling with the surface temperature close to 40. The explanation is that the ground is warm and just above the ground the air is quite cold so the snow does not have time enough to melt. However, the temperature, if it continues to snow, generally drops as the air moving in is colder and the ground is cooled.

Grade 3

Experience in addition can be obtained just as in grade 2. Practice in subtraction can be gotten as described in grade 2 with the problems made more difficult according to what has been taken up in subtraction. Experience in multiplication can be secured by determining the total amount of precipitation we will get in the next three (or as far as you have gone in multiplication) months if it rains the same amount in each of these three months as it rained last month, or some other month that the teacher selects. The choice would depend on the amount of precipitation and how difficult a multiplication problem the pupil is ready to work. The record for the Chicago area is slightly more than twelve for the month of October in 1954. The Chicago record for a period of 24 hours is slightly more than six inches of precipitation in 1885 during August.

The answers obtained by multiplication can be checked by addition and this would provide the pupil with more practice. An introduction to fractions can be made by having the pupils observe the level of the water in the rain gauge. Most of the time it will be between two inch marks rather than at a whole inch. The students can be asked to estimate what fraction of an inch the water level is at.

Fractions can also be introduced by making a large ribbon thermometer (see first grade) with the degree markings one inch apart. The student then can be asked to estimate the fraction of a degree that the ribbon thermometer reads.

Grade 4

One of the important scientific attitudes is accuracy. In order to get more accurate readings on the amounts of precipitation it is necessary to construct a better rain gauge. Blough and Campbell (see discussion under first grade) on page 114 describe a rain gauge. appropriate for the intermediate and upper grades. I would suggest two straight sticks for use with this instrument. One should be graduated in tenths of an inch, and the other in eighths. The use of

both of these sticks each time that the amount of precipitation is measured will enable the pupil to see the connection between decimals and fractions. It should be noted that these measuring sticks would be inaccurate for use with the regular rain gauge used for grades one through three.

Experience in addition can be gotten by adding the amounts of precipitation for a cumulative monthly record, and then adding the monthly amounts to get the annual total.

Experience in subtraction can be secured by ways described for the previous grades except that this time decimals are used. Data can be obtained from the *LOCAL CLIMATOLOGICAL DATA with Comparative Data* for the previous year for the city nearest you which has a weather station. For example, compare the amount of precipitation which we obtained for October of this year with October 1955 which had 5.37 inches, October 1954 which had 12.06 inches, and so forth with the answers to be given to two decimal places, or one depending on what the pupils have studied.

Additional practice can be gotten in using decimals by having the students read the aneroid barometer if your classroom is fortunate enough to have one. If there is none in the classroom, perhaps one could be brought in by a pupil. They can be read accurately to the nearest tenth of an inch and the nearest hundredth can be estimated if you are working with two decimal places.

Experience in multiplication can be obtained by having the student multiply last month's measured precipitation amount by twelve to get the annual total. It should be pointed out to the student that this is a very unreliable scientific way of finding this total and explain that the amount varies from month to month and when we multiply we assume that it does not vary.

Practice in division can be obtained by giving students the totals of certain types of days over a period of months and have them find the average. Of course, the teacher would select sums from the data and numbers of months so that there would be no remainder. As a matter of fact, the pupils could also get practice in addition by giving them the raw data which the teacher has checked and then having them add and then divide.

The pupils can be asked to make bar graphs for each month using data from *LOCAL CLIMATOLOGICAL DATA with Comparative Data*. Ideal for this purpose is a graph showing the number of each type of day for a specific month. Twelve graphs of this type could be made and the children could then get practice in interpreting graphs by being asked questions such as which months of the year in Chicago in 1955 had the most clear days, the most days on which precipitation occurred, and so forth.

Children could get experience in line graphs by plotting daily maximum temperature against the day of the month for one whole month, or average monthly temperature for each month of the year. Then they could be asked questions involving interpretation of the graphs.

GRADE 5

Practice in addition could be obtained as described in grade 4 with the problems being made more difficult such as involving two decimal places rather than one. The same can be said for subtraction and multiplication.

Practice in division can be gotten by giving the student the monthly daily maximum and minimum temperatures and having him calculate the monthly average temperatures. This would involve adding the first two and then dividing the sum by two.

At this time the pupil can be introduced to another temperature scale, that of centigrade. The temperature of science as far as the study of weather is concerned is based on the centigrade system. At sea level at normal atmospheric pressure water will boil at 100 degrees centigrade and freeze at 0 degrees centigrade. All upper air temperatures measured by weather observers and meteorologists are in centigrade. Outside of Great Britain the European countries use the centigrade scale in recording temperatures.

I have set up a simple set of operations so that Fahrenheit can be converted to centigrade and vice versa. Any fifth grade student of average ability can do this. To change Fahrenheit to centigrade the procedure is as follows:

1. Record the Fahrenheit temperature
2. Subtract 32 from it
3. Multiply the result in step 2 by 5
4. Divide the result in step 3 by 9 and you have the answer in centigrade

The teacher should not have temperatures below 33 degrees Fahrenheit converted as advanced concepts will be brought in unnecessarily at this time.

In order to convert degrees centigrade to Fahrenheit the procedure is as follows:

1. Record the centigrade temperature
2. Multiply it by 9
3. Divide the result in step 2 by 5
4. Add 32 to the result in step 3 and you have degrees Fahrenheit

The teacher should not have temperatures lower than one degree

centigrade converted to Fahrenheit as this will bring in concepts too difficult for the fifth grade student.

Grade 6

Practice in addition, subtraction, multiplication, and division as described previously can be secured by the sixth grade students with the problems being made more difficult. For example, changing 38.2 degrees Fahrenheit to centigrade rather than 38.

The concept that normally the atmospheric pressure is 14.7 pounds per square inch can be tied in very nicely with area. The fact that the atmosphere can crush a metal can which has had most of its air removed is looked upon as rather remarkable. However, when a 200 pound adult steps on a metal can and thereby crushes it, this event is taken for granted. Actually more weight is applied to the can by the atmosphere. Let us see why this is. As this demonstration can be found in almost any physical science book I will not take space to describe it. The important point is that the atmosphere exerts a pressure of 14.7 pounds per square inch. This means that the weight of a column of air from the surface of the sea to the top of the atmosphere which rests on an area of one square inch (the size of a postage stamp) is normally 14.7 pounds. Let us measure the surface dimensions of one side of the can. As we are using a one gallon can we get 5 inches by 8 inches. This then gives us an area of 40 square inches. When 40 is multipled by 14.7 the result is 588 pounds. This means that the weight of the atmosphere on the face of the can amounted to 588 pounds. Is it any wonder that the can was crushed? Other pressures can be calculated such as the total pressure on a table, on a newspaper, and so forth.

Practice in the addition of fractions can be obtained by keeping the record of the precipitation in inches and fractions of an inch, and keeping cumulative totals.

Practice in the subtraction of fractions can be obtained by studying evaporation. For this study a large aquarium jar is used. Water is put in the jar and then by means of a special stick graduated in fractions rather than demimals a daily record is kept of the amount of water in the jar and the amount that has evaporated. Factors influencing evaporation can be also studied by noting the evaporation and the temperature of the room, the evaporation and the rate of movement of air by using a fan for a certain length of time, and the evaporation and the surface area. The latter would give practice in the determination of the aea, and different shaped containers could be used.

Grade 7

This is an excellent time to bring in the metric system. Barometers

are read in inches, millimeters, centimeters, and millibars. The last mentioned term is universal and appears on all weather maps. In Europe outside of the British Isles distances on road signs are in kilometers. One kilometer is 1000 meters. One meter is 1000 millimeters or 100 centimeters. From this relationship we can see that 1000 millimeters equal 100 centimeters, or 10 millimeters equal one centimeter. One centimeter is smaller than half of an inch. Actually it is almost 0.4 inch. One inch is equivalent to 2.54 centimeters. In our study of weather the metric unit used for reading the barometer is the millibar. One inch equals 33.86 millibars so to change our reading in inches to millibars we multiply by 33.86. At the bottom of the United States Weather Bureau maps is a scale for converting inches to millibars. Many problems can be given for converting inches to millibars and vice versa. Weather maps can be obtained from the U. S. Weather Bureau in Washington, D.C. for the nominal price of two cents each. On these maps all station pressures are in millibars.

The study of relative humidity can be used to advantage when percentage is being studied. Relative humidity is a percentage, 100% or close thereto when it is raining, snowing, or foggy and low when the day or night is clear. On a clear day and night the relative humidity is at a minimum about 1 or 2 P.M. at the maximum temperature, and at a maximum when the temperature is the lowest, generally daybreak.

A simple instrument for determining the relative humidity can be easily constructed. Two small thermometers which read the same are fastened to a piece of wood shaped like a ruler. The bulb of the lower thermometer extends beyond the lower border of the wood. A hole is drilled through the top of the wood and a bolt through the hole is attached to a handle so that the wood on which the thermometers are fastened can be made to whirl. A piece of cloth is fastened to the lower bulb and moistened. The stick is whirled and readings taken until a minimum temperature is reached. Hygrometric tables which can be found in most physics books are consulted and the relative humidity determined.

An important principle is demonstrated decisively here. The temperature of the dry bulb does not change, but that of the moistened bulb decreases depending upon how much moisture there is in the air. The principle is that evaporation is a cooling process. The closer the wetbulb temperature is to the drybulb temperature, the closer the relative humidity is to 100%.

In the use of relative humidity tables interpolation is necessary and the student will get much practice in this. The student can also calculate the dew point from the same data he used to calculate the relative humidity. Again practice in using tables and making interpolations is a byproduct.

GRADE 8

In this grade the student can get practice in using formulas by converting centigrade to Fahrenheit and vice versa.

More experience can be gained in making calculations of relative humidity from data which the student himself obtains, and of the dew point.

Weather maps can be secured and studied with emphasis on points such as these:

1. Note the temperature and the dew point where there is fog; where there is precipitation.
2. Note the sky condition where there is a large spread between the temperature and the dew point.
3. How are isobars drawn? Isotherms?
4. Wind velocities are given in miles per hour and knots. How can one be converted to the other? How many miles per hour is 10 knots? How many knots is 30 miles per hour?
5. Notice the relationship between wind velocities and the number of isobars in certain areas, the closeness of isobars.

In order to have the student practice his fundamental arithmetical operations he can be asked to calculate the average amount of precipitation for one or more specific months for the last 10 or more years. He can be asked to plot line, bar, circular graphs. He can be asked to calculate the deviation from the mean of the monthly temperatures, the monthly amounts of precipitation, and the types of days for each month.

This list of suggestions for integrating arithmetic with science in the study of weather in the elementary school is by no means complete. It should serve as a springboard for each teacher who wishes to try to tie in arithmetic with science and it should point the way for correlation of arithmetic with science in such additional sub-areas as water, heat, and electricity.

SCIENCE AND MATHEMATICS IN THE SCHOOLS

On Saturday, March 2, 1957, Northwestern University School of Education and Evening Divisions will hold a conference "Improving the Teaching of Science and Mathematics in the Public Schools." There will be a talk by Dr. John Mayor of the AAAS. This will be followed by four discussion groups on science and mathematics at the elementary and secondary levels. The conference will be held in Thorne Hall—The Chicago Campus of Northwestern University at Superior and Lake Shore Drive. Registration will be from 9–9:30 and the Conference will conclude at noon. Copies of the program and further information may be received by writing to Dr. Jack R. Childress, Assistant Dean, The School of Education, Northwestern University, Evanston, Illinois.

Paint Brush for both the amateur and professional painter is angled. The rhomboid shape, it is claimed, forms two sharp cutting edges for cutting in, and gives extra brush surface for flat application.

THE USE OF A READINESS TEST IN TEACHING A UNIT ON SIGNED NUMBERS

CLARENCE E. OLANDER
Senior High School, St. Louis Park, Minnesota

INTRODUCTION TO THE PROBLEM

In the elementary school students are given readiness tests before beginning the study of a new topic. Although this procedure has been used successfully at this level, it has not been extensively attempted in the secondary schools. However, the writer feels that the problem is one meriting great concern. Too often subject matter in secondary mathematics is placed at a certain grade level without any consideration given to its level of difficulty. Students are not given tests to determine if they are able to understand the basic concepts involved or if they have mastered the basic information, principles, and skills that are necessarily prerequisite to the successful attainment of the skill or ability in question.

The purpose of this article is to describe a study in which an attempt has been made to accomplish the following concerning readiness for a unit on signed numbers in the ninth grade:

1) Develop a readiness test for the unit.
2) Develop a criterion test to be used at a subsequent time.
3) To discuss the experimental procedure necessary to test the effectiveness of the use of the results of the readiness test for two purposes:
   a) Diagnosis of factors likely to interfere with success.
   b) Prediction of future achievement.
4) To design an experiment and collect and analyze the data necessary to determine if the readiness test is functioning in either diagnosis or prediction or both.

THE TESTS

The readiness test which was used in this study was constructed chiefly from a diagnostic point of view. An attempt was made to analyze the basic skills, concepts, and abilities necessary for successful mastery of a unit on signed numbers. Items were then constructed which would measure the present status of the individual with respect to these prerequisites. The items chosen for the readiness test would have to correlate highly with some criterion of learning such as an achievement test if the readiness test is going to be valid for predictive purposes. The achievement test used in this study attempted to measure the status of the students with respect to the major objectives of a unit on signed numbers. To construct the items the objectives of the unit were considered as well as the content of the unit.

The following items represent a sampling of the kinds of items that were used in the readiness test. The entire test included eighty items.

READINESS TEST ON SIGNED NUMBERS

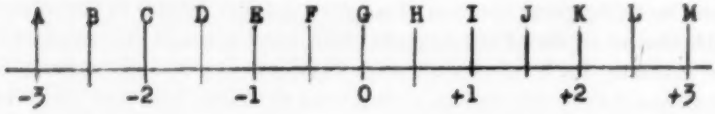
(A sample of 30 of the 80 items included in the test)

Part I (The meaning of signed numbers)

I. In items 1–10, write the opposite of each of the following in the blanks provided *on the answer sheet.*

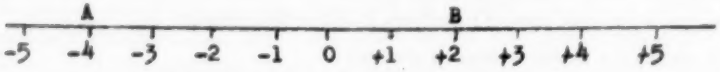
1. Profit
3. Sunrise
8. North Latitude
10. Divide

II. (Note: To indicate opposite directions or characteristics signed numbers are used. Use positive numbers (+) to show these: right, up, north, east, profit, assets, and credit. Use negative numbers (−) to show left, down, south, west, loss, liabilities, and debit.) In items 11–20, tell what letter identifies each quantity or term on the horizontal "number scale" below. Put your letter in the space provided for it *on the answer sheet.*



11. A gain of $2
18. A point 3 miles south
14. The third floor of a building
20. The equator

III. Using the horizontal "number scale" below answer questions 21–25. Put your answers in the spaces provided *on the answer sheet.*



21. Starting at zero on the number scale, go a distance represented by +3 followed by a distance equal to +2. At what point on the number scale have you arrived?
25. How far is it from point B on the number scale to point A?

IV. In items 26–30, state the quantity that is the opposite of each of the following. *Use the blanks on the answer sheet for your answers.*

26. 28 degrees north of the equator
30. 18 degrees below zero

Part II (Computation)

V. Use the thermometers below to answer items 31–45: (Note: A plus sign (+) shows that the reading is above zero. A minus sign (−) shows that the reading is below zero.) Put your answers in the blanks provided for them *on the answer sheet.*

(Drawings of two thermometers registering temperatures of 10° above zero and 5° below zero.)

31. The reading on thermometer A was 10° above zero (+10°) and increases to 12° above zero (+12°). What was the increase in temperature?
34. The temperature drops from 4° above zero (+4°) to 2° above zero (+2°). What was the decrease in temperature?
36. The temperature drops from 6° above zero (+6°) to 7° below zero (−7°). What was the drop in temperature?
37. The temperature increases from 15° below zero (−15°) to 18° above zero (+18°). What was the increase in temperature?

In items 38–45 use signed numbers to represent your answers.

38. One morning the temperature was 5° above zero (+5°). By afternoon

the temperature changed to 20° above zero (+20°). Represent this change in temperature by means of a signed number.

45. Was the change in item No. 38 in a positive or negative direction?

VI. Express the result in each of the following by means of signed numbers. Put your answers in the spaces provided for them *on the answer sheet.*

46. Earning $10, then spending $5.

51. Walking 12 miles east, then 4 miles west.

55. To a gain of 40 yards add a penalty of 15 yards.

VII. In items 56–60, read the problem carefully and then express the result as a signed number *on the answer sheet.*

56. Suppose that the temperature has been rising steadily at the rate of three degrees per hour. This hourly change is +3°. It is now four hours since the steady rise began. "Four hours since" is +4 hours. Represent the change in temperature in the four hours by means of a signed number.

60. A football team got the ball on its own forty-yard line. The team tried 3 running plays and gained 3 yards each time. Represent this change in yardage by means of a signed number.

VIII. Given $a=3$ and $b=9$, find c in each of the following examples. Put your answers in the spaces provided *on the answer sheet.*

61. $a+b=c$ 65. $ac=b$ 69. $4ac+9=9$

IX. Solve the following equations: 71–80. Put your answers in the proper spaces *on the answer sheet.*

71. $\frac{n}{7}=1$ 77. $6b+0.2=0.38$

74. $15=b-5$ 80. $24=\frac{Y}{2}+12$

The writer realizes that this readiness test is not a refined instrument. However, it represents a beginning since very little previous work has been done in the area of readiness for a unit on signed numbers. An item analysis of the readiness test was made for the experimental group in order to ascertain areas in which the student could presumably profit from diagnostic instruction. The majority of errors fell in the following categories: the inability to solve problems in signed numbers by the use of a number scale, the inability to solve problems in signed numbers using concrete quantities, and the inability to apply previous learning involving substitution and equation solving in terms of positive numbers only.

Experimental Procedure

Two classes were randomly selected to function as the experimental and control groups from five possible freshman mathematics classes. The two classes involved were not grouped according to ability of any kind. Although the two classes were selected at random from five possible classes, rigorous selection techniques for obtaining a random sample of students within the classes were not employed. The students within the classes represented an administrative selection based on class schedule similarities.

In the control group a unit on signed numbers was taught in the traditional manner using a conventional algebra textbook as the basic reference. The experimental group differed from the control group in that the teacher had available the results of the readiness test and used those diagnostically. In the teaching of the classes several other factors were considered in order to improve the scientific reliability of the experiment. Variables such as teacher, content teaching method, time, and learning activities were carefully controlled by requiring them to be the same in both classes. Supervised study, discussion, and drill were used to replace the experimental factor in the control group. Three additional classes used in determining correlation coefficients were taught in the same manner as the control group.

Three unique teaching techniques comprised the differentiation of instruction in the experiment group. These techniques were the grouping of students with similar deficiences, individualized instruction, and the use of worksheets based on the inductive method of teaching. In determining how to differentiate the instruction, the results of the readiness test were analyzed and the conclusion drawn that the above mentioned procedures would be the most effective in correcting the deficiencies of the student.

At the beginning of the unit each class was given the readiness test and also a pretest on signed numbers. This pretest was also administered as the final achievement test or post test. The pretest was important in determining the initial information of the students concerning signed numbers. Mental test scores were also available to hold constant the effect of mental ability. The scores from the mental ability, test, pretest, readiness test, and post test were used as the basis of the statistical analysis.

The Statictical Analysis

As previously mentioned, the investigator was concerned with the functioning of a readiness test on signed numbers in diagnosis of factors likely to interfere with success and also with the problem of predicition of future achievement. In order to determine the role of a readiness test in diagnosis, the data from the tests mentioned above for the experimental and control groups was analyzed by the use of Fisher's "t" test. This enables one to test the hypotheses that for each test the two populations involved have the same mean. In using the "t" test, the assumption is made that the variances of the two populations are equal. To test this assumption of equal variances, the F-statistic was used.

The writer is well aware of the limitations of the use of the "t" test in this situation. More adequate and powerful techniques such as

the methods of analysis of variance and covariance are available but the use of these methods was beyond the scope of the study. However much of the basic data necessary for these techniques has been computed and could be used in conducting further research.

In ascertaining the predictive value of the readiness test, correlation coefficients between the readiness test scores and post test scores were determined for both the experimental and control groups. The correlation coefficient in the experimental group was .68 as compared to .60 in the control group. The "Z" statistic was used to test the null hypothesis that the two populations have the same correlation coefficient between the readiness test and the post test.

Since the basic data were available for five classes consisting of one hundred forty-six students, all possible combinations of test results were used in computing the following correlation coefficients:

Correlation between	Correlation coefficient
Mental test and Readiness test	.56
Mental test and Pretest	.40
Mental test and Post test	.52
Readiness test and Pretest	.31
Readiness test and Post test	.63
Pretest and Post test	.39

Conclusions

For each of the four tests the null hypothesis that the two populations have the same variance was accepted. It was necessary to show this since in using the "t" test the assumption is made that the variances of the two populations are equal. Similarly, in each case the null hypothesis stating that the two populations have the same mean was accepted. In other words, the means of the two classes for each of the four tests involved are not significantly different. The pedagogical conclusion is that there appears to be no real difference between the average achievements and abilities of the two classes as measured by the tests used.

As mentioned previously, no attempt at matching or rigorously holding constant some of the variables was made. However, on the basis of the "t" test applied to the data of the final achievement test, it appears that there is no significant difference in achievement resulting from the use of the results of a readiness test in diagnosis. The experimental group attained a greater mean on the final test, but this difference was not significant. It may have been due to the higher mean scores achieved on the readiness test and the pretest.

In testing the significance of the difference of the correlation coefficients between the readiness test and post test, for the experimental and control groups, the null hypothesis that the two populations have the same correlation coefficient was accepted. One must therefore conclude that the use of the results of a readiness test in diagnosis

does not affect the correlation between the readiness test and the end test.

On the basis of the results presented above, the following conclusions are stated:

1. The means of the two classes for each of the four tests are not significantly different.
2. There is no significant difference between the correlation coefficients between the readiness test and post test for the experimental and control classes.
3. Of the six possible combinations of correlation coefficients, the correlation between the readiness test and the post test is the highest.

Implications

Certain implications appear warranted as a result of this study. The writer feels that although the achievement of the students was not significantly different between the experimental and the control groups, the diagnostic use of the results of the readiness test has its place in mathematics instruction. Students in the experimental group were more satisfied in their individual progress. Each student had the advantage of remedial instruction based upon his performance on the readiness test before being introduced to new material involving previous learning. Since the element of diagnosis is almost entirely lacking in secondary mathematics, it seems reasonable to imply that the approach used in this experiment is pedagogically sound. Too often the assumption is made by teachers that students possess certain basic skills and understandings necessary for success in the study of a particular concept. The results of this experiment indicated that this is not necessarily true. The lack of significant results in this experiment may have been due to factors other than the approach which was employed. Other teachers interested in the use of a readiness test diagnostically might devise more ingenious methods of applying the results of the readiness test. Procedures such as more extensive group work, more effective worksheets, the use of visual aids, and differentiated assignments could be tried out and refined by other interested teachers.

The writer feels that one of the objectives of this experiment was to create some interest in this approach among fellow teachers. An effort has been made to show both through experimentation and discussion that the approach is a sound one. It is not unreasonable to expect that other teachers using the same approach with different and improved tests and teaching procedures might obtain significant results.

Prediction is another area characterized by its absence from the scene of mathematics instruction. Since a relatively high correlation

was obtained between the readiness test and the post test, one can be enocuraged to the extent that after further refinement a test of this nature could function in prediction. One must remember that the items were designed to be used primarily for diagnosis. Other teachers interested primarily in prediction could observe from this experiment that it is possible to construct test items which will function in prediction. After careful deliberation, a teacher might discover many other implications for his teaching which will lead to more effective learning, the primary objective of teaching.

Testing instruments played an important role in the outcome of this study. The design of an instrument which will measure all the factors upon which an analysis of superiority of achievement can be made is extremely difficult. It is entirely possible that better instruments would have changed the outcomes of the experiment. Repeated research would be necessary to refine and validate both the readiness test and the post test. It is the problem of the investigator to improve his testing instruments.

Replication would be necessary before any reliable conclusions could be made concerning readiness testing at the secondary level. It is only through continued experimentation that improvement in instruction can be accomplished. The experience gained in this study can make the next study more scientific and reliable.

Before any other inferences could be drawn from the data, one would have to use more powerful statistical techniques such as the analysis of variance and covariance. The analysis of variance and covariance is a statistical technique which enables one to make a rigorous test of significance of mean differences of randomly selected groups. The analysis of covariance makes it possible to adjust outcome scores for differences in pretest scores in the related area and mental ability. This adjustment is made in terms of regression of the outcome score upon the initial score and mental test score. Another possibility for the experimenter would be to investigate the effect of the experimental factor on students of varying ability. This could be done by employing the Johnson-Neyman technique to set up a region of significance to determine for what kind of students a significant difference in means would be found and for which group.

Another factor that should be considered in further research would be the effectiveness of various materials of instruction in the development of appreciations, attitudes, and insights. In the opinion of the writer, the prediagnosis of errors likely to interfere with success and the correction of these errors would create better understanding of the subject matter being presented. This better understanding and individual satisfaction could consequently lead to a better attitude on the part of the student. Additional experimentation might include the

development of an attitude test to be used in conjunction with the problem.

It is the decided opinion of the writer that the approach described above definitely should have an important place in the teaching of secondary mathematics. Further interest and research are necessary before the role of a readiness test can be definitely determined.

ADAPTING THE BODY TO HIGH ALTITUDES

Scientists in the world's highest laboratories in the Andes mountains are learning how the body adapts itself to living nearly three miles above sea level.

Long-range studies being conducted by doctors in Peru show that natives living at extreme altitudes exhibit definite differences in some physical characteristics and in their succeptibility to certain diseases.

Progress of the research was reported to University of Wisconsin Medical School faculty and students by Dr. Alberto Hurtado, dean of the faculty of San Marcus Medical School, Lima, Peru, director of the study.

The main laboratory for high altitude research is at 14,900 feet, Dr. Hurtado said, but there are smaller laboratories at altitudes up to 17,000 feet. Natives living at these altitudes have acclimatized themselves to the extremely thin air through a series of adaptive mechanisms. Their bodies contain more blood than persons living at sea level, they tend to hyperventilate, or breathe very rapidly and deeply, and there are some changes in tissue structure, but just what these changes are has not yet been completely determined.

Individuals differ a great deal in how they acclimatize themselves, the doctor said. The longer a person remains at a high altitude the better adapted he becomes.

If a person were suddenly transported from sea level to an altitude of 15,000 feet it would take several months before he became acclimatized, Dr. Hurtado said. Men who are engaged in the research gradually ascend from laboratories at lower levels so they will not experience headache, fatigue, nausea and other disorders of the central nervous system common to persons who are not acclimatized.

Altitude seems to have a marked effect on the appearance of some diseases, the doctor said. For instance, there is a noticeable decrease in the number of cases of high blood pressure and heart disease at high altitudes, and a noticeable increase in the number of cases of peptic ulcer. As yet scientists do not know the reasons why.

LAWRENCE R. HAFSTAD OF GENERAL MOTORS SPEAKS

The General Motors vice president advises today's science students to steep themselves in the fundamentals of the field. At the same time he warns that atomic science is not a calling for the average student. He cites as qualifications for success in the field an above-average mathematical aptitude; imagination; intellectual curiosity; patience and a willingness to keep trying; a capacity for hard work; an ability to collect data, organize facts and analyze them; and the willingness to be a non-conformist—to get off well-traveled mental highways and strike out for onseself.

"Atomic science," Mr. Hafstad concludes, "insists upon a high level of mental refinement, and I think it is important for us to try to train our youth up to it."

FIRE AS A SUBJECT IN ELEMENTARY AND GENERAL SCIENCE

JOHN D. WOOLEVER
Sarasota Public Schools, Sarasota, Florida

Only recently have a few elementary science texts included material on fire as a phenomenon worthy of serious consideration. General Science and Chemistry treat it in terms of oxidation in introducing chemical changes and equations. It is a mistake to ignore fire in the elementary program with merely discussion type warnings during fire prevention week usually terminating in a trip to the local fire station. In the later elementary grades this gradually dwindles to distribution of leaflets, a few posters and an omission of the field trip.

Thousands of fires are started by youngsters who have read of fire's potential danger but are totally unaware of how fires start. After four years of testing six different grade levels of elementary school children, this author has found that the average pupil knows only three or four ways to start a fire and only rarely knows what principles are involved in causing any kind of combustion.

The subject lends itself to being studied at any time of the year. It can be used in the fall when forest fires, leaf and weed burning are common experiences. Christmas time is another occasion when home fires increase. In the spring, people start burning remaining weeds and other trash in the open again. Of course Fire Prevention Week is another opportunity to review any preceding science experiences regarding fires.

Fire is an action subject. It draws the interest of every student and the teacher demonstrations can arouse any lagging interest. The action produced by boiling water in a paper container, exploding hydrogen soap bubbles, burning acetylene on ice or spontaneously exploding pyrophoric powders in air will attract the daydreaming student. There are dozens of spectacular teacher demonstrations to be found in publications such as SCHOOL SCIENCE & MATHEMATICS, *Chemical Engineering News*, *Chemical Education* and *The Science Teacher*, all of which can be added to a unit on fire. For schools that have auditoriums, special programs on fires can be arranged through some of the oil companies and local fire fighting departments.

No teacher should be at a loss for illustrative materials. The Underwriters and the National Commission on Safety Education have posters for class use. The daily newspapers and weekly magazines frequently play up spectacular fires.

Inexperienced teachers should remember that permission ought to be obtained from the principal before demonstrating anything unusual involving fire. Frequently administrators feel that teaching

about dangerous things is as dangerous as the actual thing itself. For practical purposes and psychological effect, a fire extinguisher should be at hand and the students should not sit closer than ten feet from any actual flames. Female demonstrators should avoid wearing any flimsy or fancy clothing, and be sure that the lab. apron is fire proof. All papers should be removed from desks and demonstration tables. A metal screen between fire and students is an optional precaution.

The purpose of studying fire is to make the student familiar with fire, to have him understand its composition, what it does, what it needs, its potential dangers and how it is controlled. If he is familiar enough with it not to be frighened by it but has a healthy respect for it and understands it, he is more likely to prevent and control it. His thinking should be clearer, and his conduct more orderly when facing a hazardous conflagration.

These units offer opportunities for correlating studies in Science, Social Studies and Industrial Arts. Fire can be studied as it relates to the historical importance in early family life, warfare, industry, and religious practices. Many of the things to be constructed herein can be made in the science room, the shop, or as individual home projects.

It should be noted that as the units progress, fewer experiments are performed by the pupils and more demonstrations are conducted by the teacher. This is obviously a safety precaution as the demonstrations increase in complexity. By this time however, the pupils have had many experiences with fires, vicarious and otherwise so that they don't need personal contact with the activity beyond the demonstrations in class. Experiments and questions are primarily designed to lead to reasoning and practical application of the principles involved. Although not always found in the questions listed, it should be constantly in the mind of the teacher to ask the *what*, *where*, *when*, *how* and *why* of the fire in order to require active thought about the subject by the pupils in attendance.

GRADE 4 & 5

UNIT: FIRE

Theme I: There are many ways to start a fire

a) Friction results in heat and is important in the use of matches, cigarette lighters, and early methods of fire making.
b) Fire can be started by electrical sources, concentrated rays of the sun and all kinds of sparks.
c) Early methods of starting fires may have resulted from falling meteorites, volcanoes and lightning striking trees.

This unit can center about early methods of fire-making traced to the present day. Although the same principles are used then as today, they are merely simplified and in a more convenient form. Conditions conducive to starting fires and

carelessness in allowing conditions to exist where a fire may start, results in great loss. Recognition of these conditions can aid greatly in fire prevention. Knowing how a fire can start can prevent a fire from starting.

Theme II: Many methods are used to control and stop fires

a) Reducing fuel can control fire.
b) Fires can be stopped by smothering.
c) Fireproof materials aid in fire control.
d) Various methods are used in controlling forest fires.
e) Fires in stoves and furnaces are controlled by mechanical adjustments.
f) Not all fires are extinguished in the same way.

Familiarity with fire fighting and control can benefit the individual by helping prevent fire losses. It also aids in knowing which are the proper and improper methods in special cases where unwise use of improper materials may do more harm than good.

Theme III: Some things catch fire more easily and burn more quickly than others

a) Gasoline and oil fumes ignite very easily.
b) Most thin materials catch fire more quickly than heavier, thicker substances.
c) Fuels vary in their kindling temperatures.
d) The intensity of fire increases with the amount of air or oxygen it receives.

A knowledge of the variation in kindling temperatures and susceptibility of various objects to fire and burn quickly, not only may aid in fire prevention but also can lead to understanding the study of the chemistry of fire.

DEMONSTRATION EXPERIMENTS BY TEACHER

Things to do:

a) Make some early fire-making tools. Demonstrate & use.
b) Start a fire with a "fire piston."
c) Start a fire with stick and bow.
d) Make some "lucifers," demonstrate.
e) Start fire with flint and steel. Compare with cigarette lighter.
f) Rub finger on coat and demonstrate sparks.
g) Show how fire can start with ragged electric cord using batteries and compare with toaster and resistance coil.
h) Test and compare materials for kindling temperature such as plastics, wood chips, wet wood, leaves, cloth, coal, metals, etc.
i) Compare kindling temperature of cloth before and after "fireproofing" with "waterglass."
j) Examine a burning candle, kerosene lamp, gas burner. Find out how and why it burns.
k) Show the importance of air; not enough and increased amounts on hot coals, etc.
l) Demonstrate an acetylene torch.

Group activities: With teacher, by teacher or under his direction

a) Visit local firehouse. Be sure each student knows how to operate a fire alarm box, and knows method of reporting a fire. Equipment at station gives excellent opportunity to demonstrate other scientific principles in operation, pressure, etc.
b) Examine fire extinguisher. Make small soda extinguishers.
c) Flameproof and fireproof some materials with "waterglass" or other fireproofing chemicals.

d) Collect asbestos objects, give reasons for use in construction material, test it.
e) Build or examine models of stoves, fireplaces and furnaces, other heating systems.
f) Extinguish small fires in school yard, using sand, water, CO_2, salt, rugs, etc.
g) Build some portable fire escapes.
h) Draw some "Do and Don't" posters.
i) Collect different kinds of fuels. Discuss advantages of each.

Experiments to be performed at home. Report results

a) Rub some wood with sand paper, emery paper or emery wheel, feel it.
b) Repeatedly bend back and forth some wire or soft metal, feel it.
c) Rub fingers very lightly but quickly on surface of paper.
d) Rub hands together quickly, several times.
e) Watch for flying sparks when knives or other instruments are sharpened.
f) Feel a drill after it has bored a hole.
g) Feel a saw blade after use.
h) Feel nails after hammering or after being removed from board.
i) Feel tires after a long fast drive.
j) Walk across carpet, collect static electricity.
k) Make static electric sparks with conventional laboratory equipment.
l) Build a model air blower, inflate and demonstrate operation.
m) Let each student diagram his own home and point out danger points of fire hazards, air shaft drafts, safety exit possibilities, fire extinguisher locations.

Suggested topics for discussion, study and supplemental enrichment

a) Most public fires start in the following ways: lighted cigarettes, burning matches, train sparks, electric cords, dirty chimneys, neglected fireplaces, oil stoves, camp fires, lightning.
b) Community firefighting progressed from bucket brigade to modern methods, which include, fog, sprinklers, CO_2, foams, chemicals.
c) Materials at hand can be used to combat a fire at home, viz.: sand, water, blankets, salt, hand extinguishers.
d) The nature of the fire determines the fire fighting methods employed.
e) Besides amount of fuel, air flow is important in fire control in forges, stoves, furnaces, fireplaces, homes on fire, public buildings, forests.
f) Kindling temperature of materials is an important consideration in the construction of buildings, etc.
g) Fireproofing is mostly a matter of changing kindling temperature and combustibility.
h) Common items catch fire easily and are thereby extremely dangerous in spite of their common use, e.g.: cleaning fluids, gasoline, kerosene, cooking oils.

Problems to solve based on principles and experiments performed. These situations are known to arise frequently and thought applied here in solving these problems may save time when the student is confronted with the actual circumstances.

a) How can a forest fire start from a piece of glass and dry leaves?
b) How were our grandparents able to light gas lights merely with the tips of their fingers?
c) Why is it dangerous to place a spherical fishbowl in a sunny window?
d) Why might it be dangerous to have an air bubble in a window pane?
e) Why is it safer to carry a cigarette lighter in your pocket than exposed matches?
f) How are mice able to start a fire in a smoking stand?

g) Why should a match be broken in half before it is thrown away?
h) Why were some arctic explorers able to start fires with ice?
i) Why is it inadvisable to pour water on an oil fire?
j) How should electrical fires be extinguished? Explain why.
k) What are the best methods of extinguishing a camp fire?
l) How does a rug or blanket extinguish a fire when wrapped around a person aflame?
m) How can a fire be slowed down in a furnace?
n) What precautions must be observed when working around gasoline and oil.
o) What part of a candle burns and what must happen first before it will burn?

GRADE SIX & SEVEN

UNIT: FIRE

Theme I: Three things are needed to start and support a fire viz.: fuel, oxygen and heat

a) Varying the amounts of these three things alters the rate and intensity of the fire. This allows us to control fire.

Theme II: Fire is a chemical action

a) It changes the characteristics of things.
b) It gives off dangerous gases not present before burning.
c) It changes and releases different forms of energy.
d) Fire can start "spontaneously," but can be prevented.

TEACHER DEMONSTRATIONS

Show that CO_2 is given off by fire, and that it will not support another fire. Show that the CO_2 given off by a fire will not support life.

Burn paper, cloth, plastic, or a strip of Magnesium, show its changed composition and explain. Show how some ashes will not burn again, discuss why.

Make a smoke box. Explain.

Make some "lucifers" and other forms of early matches. Discuss the evolution and progress of the match, the difference between the safety match and other types.

Build a fire and show how different substances change the color of the flames. Examine and identify the parts of a flame, what they do and why flames flicker. Compare rust with fire.

Examine smoke, its composition, what it is, what it does and how it acts under different conditions, the danger involved. Discuss how to act in a dangerous smoke situation.

Examine some "fireworks," their composition, what each substance contributes, the change after use and the danger in misuse. Explain why only professionals should use them.

Produce a "spontaneous" fire. Discuss the prevention of spontaneous fires, where they are caused most frequently and factors contributing to their starting. Explain how individuals, and farmers in particular, can take measures in their prevention.

Make a carbide cannon explosion and explain. Discuss explosions and how they happen.

Make and demonstrate a baking flour cannon. Discuss this type of accidental explosion.

Experiment with oxygen to show importance of oxygen and CO_2 on flame. Put a beaker over a candle. Thrust an ember into a beaker of oxygen; pour CO_2 on a candle flame.

Demonstrate and compare as fuels, paper, candle, oil, magnesium strip and wood. Compare the flames.

Invite a fireman to speak to the class.

Perform experiments showing that reducing any of the three factors reduces the fire or flame. Discuss how this is used in fire prevention and control.

Boil some water in paper, and discuss why paper didn't burn.

Wrap paper around a brass rod, thrust into flame and discuss results, how principle involved is applied.

Build model portable fire escapes for use in homes.

Problems to consider:

What are the various principles involved when the following materials are used in extinguishing a fire?

a) Foamite
b) Sand, salt, dirt
c) CO_2 extinguisher
d) Water
e) Forest fire lines
f) Steam and spray, fog
g) Blanket or rug
h) "Blowing out" a match
i) "Breaking up" a camp fire

How and why does a "torch" burn under water, as when used in ship salvage work?

How does cleanliness aid in fire prevention?

Why doesn't water burn?

Why isn't parking allowed near a fire hydrant?

What are the methods used by fire departments in fire fighting?

Why do firemen carry axes?

Why is it unwise to hang damp clothing to dry near a stove or radiator?

What is given off by fires?

How can a vacuum cleaner bag explode?

What is the potential danger existing in flour mills and grain elevators?

"FAMOUS AMERICANS" IN PICTURES

The most interesting facts about how several famous Americans became famous are presented pictorially in a new teaching aid announced by The Jam Handy Organization.

The biographies are typically American life dramas of courage in the face of physical and financial handicaps, persistence, and a will to blaze a new trial. The people chosen are known to all. The information given about them in pictorial highlights, however, represents many interest-holding details which the student could find only by time-consuming research in the shelves.

The series, "Famous Americans," contains class-tested filmstrips in color on the lives and contributions of Thomas Alva Edison, the Wright brothers, George Washington Carver, Alexander Graham Bell, Theodore Roosevelt and Jane Addams. The material is helpful on both elementary and junior high levels in social studies, language arts and science.

Suggestions are made at the end of each presentation for class utilization of the ideas presented, as by means of exhibits, dramatization of historic incidents, and hobbycraft. Questions at the conclusion of each picture-story focus attention on the basic achievements of great Americans.

"Famous Americans" is priced at $31.50 for the entire series, or $5.75 for individual filmstrips. The material is available from The Jam Handy Organization, 2821 East Grand Boulevard, Detroit 11, Michigan, or from all authorized Jam Handy dealers.

MAGNETIC MODELS FOR COMPLEX IONS AND MOLECULES: COORDINATION NUMBER FOUR

WESLEY W. WENDLANDT
Texas Technological College, Lubbock, Texas

It is difficult to achieve success in beginning and advanced courses in inorganic chemistry without the extensive use of models. The student can grasp more easily the spatial arrangement of atoms or ions in a molecule or complex ion if three dimensional models are available. There are many different types of models; some are commerically available while others can easily be constructed from wooden or plastic balls. The models presented here are more versatile in that they allow various configurations to be assembled with a minimum of effort.

The models were constructed of $\frac{1}{4}''$ thick Plexiglass plastic glued together to form either a regular tetrahedron or a square planar configuration. The tetrahedron and the square planar models were about 6″ on an edge. At the apices of the models, Alnico magnets, $\frac{1}{4}''$ diameter and $1\frac{1}{2}''$ long, were cemented in to represent points of attachment. All of the magnets were orientated so that the same pole faced outwards. The central atom or ion was represented by a painted cork ball, $1\frac{3}{4}''$ in diameter, supported in the center of the tetrahedron by a small plastic rod. Supporting metal stands were so constructed that the models could easily be removed for manipulation by hand.

The attached molecules were made from cork balls. A convenient size for construction of the ammonia molecules was 1″ in diameter for the nitrogen atoms and $\frac{3}{4}''$ in diameter for the hydrogen atoms. A $\frac{1}{4}''$ hole was drilled into the nitrogen atoms and a $\frac{1}{4}'' \times \frac{3}{4}''$ magnet cemented in, the magnets being orientated so that the outward ends were of opposite polarity to those of the models. The completed ammonia molecules could then be attached to the models merely by making contact with the apex magnets. It was found that the magnets gave a firm bond with the attached groups. Similar attachable models were made of other ions and molecules.

Two views of the models are shown in Figure 1. In A, the model represents the complex ion, $[Ni(NH_3)_4]^{++}$, which is presumably a tetrahedral configuration. In B, the model represents the complex ion, $[Pt(NH_3)_4]^{++}$, which is square planar. It is possible to use the models to illustrate other complexes or compounds by use of different attached groups.

The models were found to be especially useful in illustrating *cis-trans* isomerism in the square planar complexes. The various groups could be attached to the model with ease while manipulating the models in front of the class.

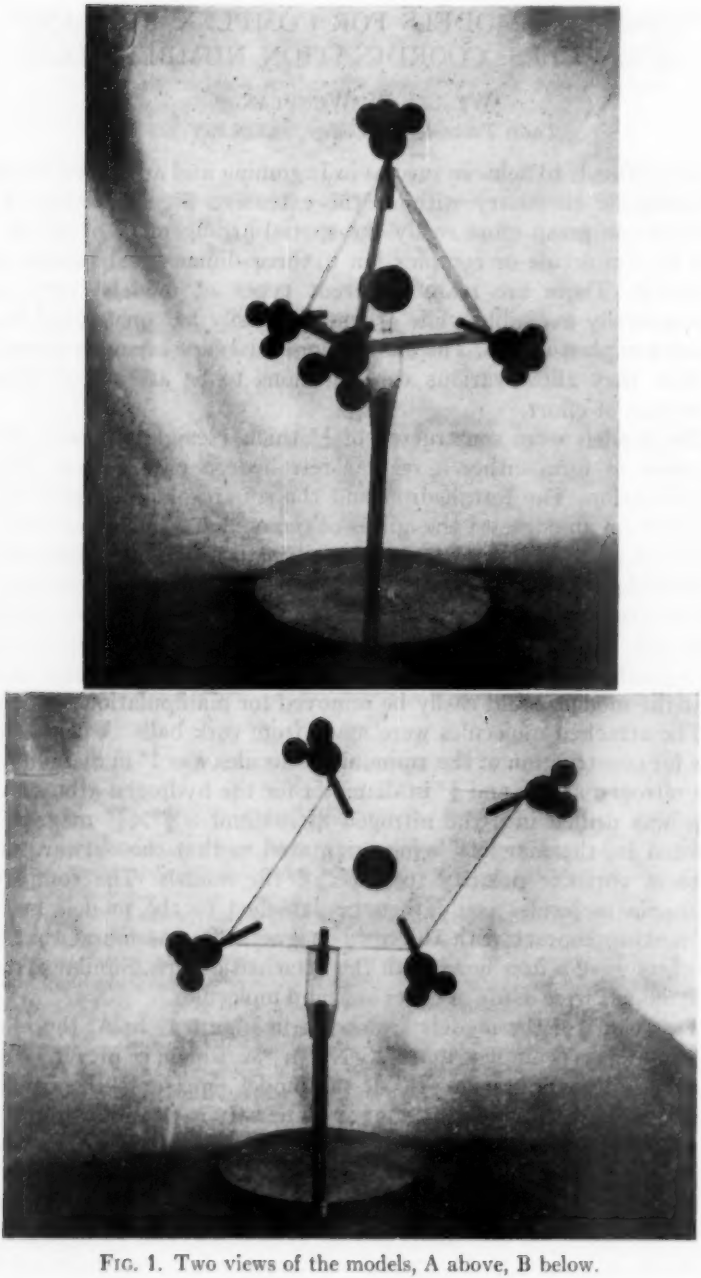


FIG. 1. Two views of the models, A above, B below.

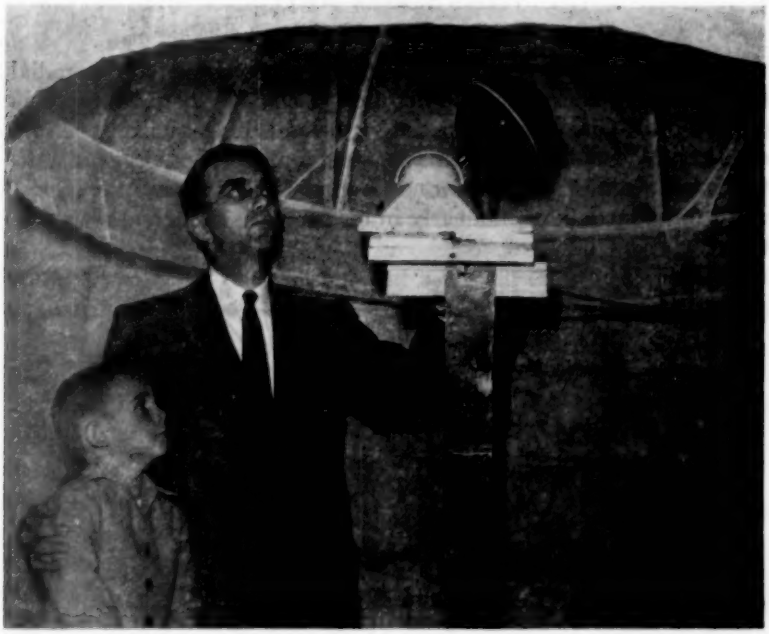
ACKNOWLEDGEMENT

It is a pleasure to acknowledge Mr. Clinton McPherson for aid in photographing the models.

A PLANETARIUM FOR THE AMATEUR ASTRONOMER

WALLACE A. HILTON
William Jewell College, Liberty, Missouri

For the past several years, small planetariums[1] have been available for home use; however when the stars are projected on the ceiling and walls of the ordinary room the constellations are distorted.



In order to prevent this distortion, it is necessary to have a hemispherical dome. An easily constructed and simple type dome is shown in Fig. 1. The supporting frame is sawed from $\frac{3}{4}$ inch plywood and the pieces are nailed together so as to make the diameter of the dome six feet. Cheesecloth is stapled to the structure and the planetarium is mounted at the center of the dome. In this case the dome is mounted in a home garage and just above the engine-space of the family car.

[1] Spitz Jr. Planetarium, Spitz Laboratories, Yorklyn, Delaware.

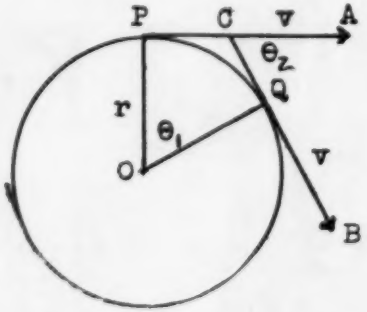
In the evening when the room is dark, the ribbed structure cannot be seen through the cheesecloth and the stars are easily seen in their correct position when projected on the dome.

In order to make the planetarium show more interesting to the local grade school and high school astronomers, flashlight bulbs are placed on the west and east sides of the dome. These are controlled by rheostats. The setting sun is represented by dimming the bulb in the west, and then after seeing the stars of the entire night, the bulb to the east is gradually turned on to indicate the rising sun.

ON A DERIVATION OF $a=v^2/r$

JULIUS SUMNER MILLER
El Camino College, El Camino College, California

There are as many derivations of the expression for the radial acceleration in uniform circular motion (*UCM*) as there are teachers of physics. No one has any special virtue and this may likely be said of the one shown here. But *I* have found a measure of elegance in it, which is enough to justify it for me! For a beginner it has some special merit for it introduces him early in his career to some mathematical beauty.



A point P moves uniformly on a circle of radius r. In a short time t let it be at Q, an angular distance θ_1 from P. $PA=\overrightarrow{QB}=v\cdot\theta_2=\theta_1$, clearly $(=\theta$, say).

The velocity at P (along PA) is v. The vector v at Q has a component $v\cos\theta$ along PA. The *change* in velocity (in the direction PA) is, therefore, $v\cos\theta-v$.

Then,

$$\Delta v = v\cos\theta - v$$
$$= v(\cos\theta - 1)$$

$$=v\left(1-\frac{\theta^2}{2!}+\frac{\theta^4}{4!}-\frac{\theta^6}{6!}+\cdots-1\right). \tag{1}$$

The *rate of change* of velocity (a) along PA, is therefore

$$v/t\left(-\frac{\theta^2}{2!}+\frac{\theta^4}{4!}-\frac{\theta^6}{6!}+\cdots\right)$$

or,

$$a=\frac{v\theta^2}{t}\left(-\frac{1}{2!}+\frac{\theta^2}{4!}-\frac{\theta^4}{6!}+\cdots\right). \tag{2}$$

Now arc $PQ=\mathrm{r}\cdot\theta$. This is described in time t. Whence $vt=r\cdot\theta$. Put this in the form $v^2/r=v\cdot\theta/t$.

Then (2) becomes

$$a=v^2/r\cdot\theta\left(-\frac{1}{2!}+\frac{\theta^2}{4!}-\frac{\theta^4}{6!}+\cdots\right). \tag{3}$$

As θ goes to zero, a goes to zero. From which we conclude that the acceleration *along* PA is zero. This confirms the premise that the motion is UCM. (Note: This could also have been read from (2).)

Further, the velocity at P has no component along PO. The velocity at Q, however, has a component $v\sin\theta$ in the direction PO. The *change* in velocity in this direction is, therefore, $v\sin\theta$. The *rate of change* of velocity in this direction is $V\sin\theta/t$ and this is a.

Therefore,

$$a=\frac{v\sin\theta}{t}$$

$$=\frac{v}{t}\left(\theta-\frac{\theta^3}{3!}+\frac{\theta^5}{5!}-\frac{\theta^7}{7!}+\cdots\right) \tag{4}$$

$$=\frac{v\theta}{t}\left(1-\frac{\theta^2}{3!}+\frac{\theta^4}{5!}-\frac{\theta^6}{7!}+\cdots\right) \tag{5}$$

$$=\frac{v^2}{r}\left(1-\frac{\theta^2}{3!}+\frac{\theta^4}{5!}-\frac{\theta^6}{7!}+\cdots\right) \tag{6}$$

which goes to v^2/r when θ goes to zero.

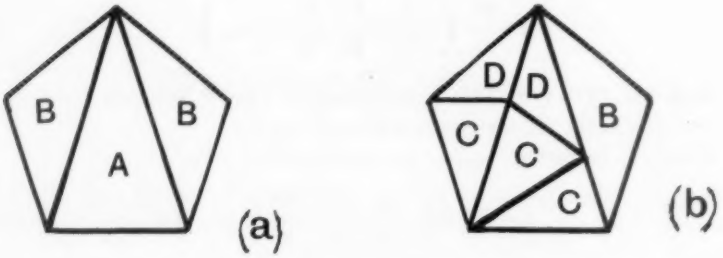
Accordingly, the acceleration is only along the radius and of magnitude v^2/r.

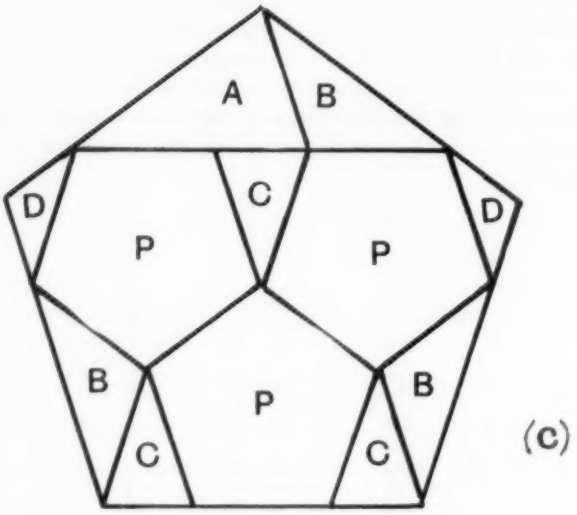
Hope for the best, get ready for the worst, then take what comes and smile.

MEET MR. TAU AGAIN

JOHN SATTERLY
University of Toronto, Toronto, Canada

In a recent paper in this *Journal*[1] I gave an account of the properties of a certain number called Tau or τ and of its relationships to the square root of five and to the geometry of the regular pentagon.





In a recent number of the (English) *Mathematical Gazette*[2] Mr. C. D. Langford carved up a regular pentagon into isosceles triangles A, B, C, D as shown in Fig. 1 (a and b). Figs. 1a is almost the same as Fig. 3 of my paper. He then shows in Fig. 1c how, by a combina-

[1] John Satterly, SCHOOL SCIENCE AND MATHEMATICS, Vol. LVI, No. 9, Dec., 1956.
[2] C. D. Langford, *Mathematical Gazette*, Vol. XI, No. 333, Oct., 1956.

tion of several of these parts, namely, one of A, three of B, three of C, two of D plus three simple pentagons P of the same size as the dismembered pentagons it is possible to build up a composite regular pentagon.

It is the purpose of this note to give the relative dimensions of the simple and composite pentagons. Take the side of the simple pentagon as unity. The dimensions of the four triangles are as given in Table I.

TABLE I

Triangle	Linear Dimensions	Angle at Vertex	Relative Areas
A	τ τ 1	36°	1 or 1 or 1
B	1, 1, τ	108°	$1/\tau$ or $\tau-1$ or 0.618
C	1, 1, $1/\tau$	36°	$1/\tau^2$ or $2-\tau$ or 0.382
D	$1/\tau$ $1/\tau$ 1	108°	$1/\tau^3$ or $2\tau-3$ or 0.236

The area of the simple pentagon is equal to $A+2B$ and thus $=1+2(1/\tau)=(\tau+2)/\tau=\tau\sqrt{5}/\tau=\sqrt{5}$.

Fig. 1(c) shows that the side of the composite pentagon $=1+2(\tau-1)$ or $2\tau-1$ which is equal to $\sqrt{5}$. The areas of similar figures are as the squares of corresponding sides. Therefore:

$$\frac{\text{area of composite pentagon}}{\text{area of the simple pentagon}}=\left(\frac{2\tau-1}{1}\right)^2=(\sqrt{5})^2=5$$

The diagonal of the simple pentagon $=\tau\times$(its base)$=\tau$. Therefore the diagonal of the composite pentagon $=\tau(2\tau-1)=\tau\sqrt{5}$. Thus we get Table II where triangle A is used as a basis for comparison of areas.

TABLE II

The Figure	Relative Sides	Relative Diagonals	Relative Areas
The Triangle A	1 and τ	—	1
Simple Pentagon	1	τ	$2\tau-1$ or $\sqrt{5}$
Composite Pentagon	$\sqrt{5}$	$\tau\sqrt{5}$	$5\sqrt{5}$

Silicone Rubber Conductor will carry an electric current without wires. Compounded with carbon black, the commercial product can be molded, rolled or extruded without changing its electrical properties, and is resistant to temperatures as high as 400 degrees Fahrenheit. The new rubber compound can be made into difficult or odd shapes, such as an electric heater.

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS

REPORT OF THE FIFTY-SIXTH CONVENTION

(Subject to Approval at the Next Annual Meeting)

NOVEMBER 22–24, 1956, EDGEWATER BEACH HOTEL, CHICAGO, ILLINOIS

I. BOARD OF DIRECTORS MEETING

THURSDAY, NOVEMBER 22, 1956, 4:00 P.M. and 7:00 P.M., BERWYN ROOM

Roll Call: Officers: Junge, Otto, Soliday, Terhune; Past President Pella; Board Members: Bos, Sister Mary Evarista, Gross, Huffer, McCormick, Panush, Read, Wren, J. Mallinson. *Journal* Editor Warner; *Yearbook* Editor Shetler; Committee Chairmen: Burton, Kennedy, Richards.

President Charlotte Junge called the meeting to order at 4:00 P.M.

Minutes of May Board Meeting: The secretary read the minutes of the May Board meeting. It was moved by Read, seconded by Gross, that the minutes be approved as read. Carried.

Review of Association Affairs: President Junge delivered a message from Cecelia Lauby, chairman of the nominating committee, asking that any suggestions the board might care to make to the committee be given to her on Friday morning.

The president called on the secretary for a report on the question raised in May as to the need for an outside audit of the treasurer's books. The secretary read the letter written by her to the New Amsterdam Casualty Co. asking if such an audit was required by them for the purpose of issuing a bond to the treasurer, and their reply that no such audit was required.

Local Arrangements: Chairman Stanley Richards presented a written report of the work of his committee. The possibility of showing the film "Our Mr. Sun" at some point in the program was discussed. It was agreed to show it at 5:30 P.M. Friday if a sufficient number of people indicated their interest in seeing it. It was agreed that the special questionnaire prepared for distribution to the section and group meetings be returned to the Association secretary for tabulation, and that pertinent information from this tabulation be sent by her to the president of the Association, the vice president, the section chairmen, and the *Journal* editor.

Place of Meeting Committee: Chairman Enoch Burton reported that Chicago, Indianapolis, and Milwaukee were the three cities considered for the 1957 meeting. Since the AAAS will meet in Indianapolis in December, 1957, his committee felt that the Association should postpone for another year accepting that city's invitation. It was the recommendation of the committee that Milwaukee be the 1957 meeting place. It was moved by Read, seconded by Wren, that we plan to meet in Milwaukee next year. In the discussion it was brought out that the invitation from Milwaukee was from the convention bureau rather than from any group of interested members. Motion defeated. It was then moved by McCormick, seconded by Read, that the Executive Committee be empowered to make a decision on the place of meeting. After further discussion this motion was withdrawn. It was moved by Otto, seconded by Read, that the 1957 convention be held in Chicago. Carried.

Emeritus Memberships: Emeritus memberships for the following persons will be awarded by Dr. Glen Warner at the Luncheon meeting on Friday: Ernest O. Bower, Cleveland, Ohio; Ira Davis, Madison, Wisconsin; G. H. Jamison, Kirksville, Missouri; Joseph A. Nyberg, Fayetteville, Arkansas; Orlando E. Overn, Milwaukee, Wisconsin; and Charles D. Wildrick, Englewood, New Jersey.

AAAS Report: Ella Marth Snader, the representative of the Association to the AAAS, was not present and no report was submitted.

Editor's Report: Dr. Glen Warner announced that the January issue of the *Journal* was completed and in, and that the deadline for material for the Feb-

ruary issue was November 30. He expressed a desire for more material for the *Journal* in the fields of Biology and Chemistry. Dr. Warner asked for suggestions for filling the position of high school mathematics editor, the position left vacant by the death of Dr. Hawkins.

Treasurer's Report: Ray Soliday had mailed in advance to all board members copies of the Profit and Loss Statement. Calling attention to the loss of about $231 in 1956, he raised the question as to the time when advertising rates should be raised or membership dues be increased. After considerable discussion, Panush moved, seconded by McCormick, that Mr. Soliday be empowered to study the advertising rates of journals of comparable size and circulation and to adjust rates accordingly as seems advisable. Carried. Following a discussion on the possibility of increasing membership dues, Panush moved, seconded by Wren, that the president appoint a committee to investigate the following three items: (1) sustaining memberships with special dues, (2) interesting firms and corporations in belonging to the Association, and (3) junior memberships, and that the committee report to the spring meeting with specific recommendations. Mr. Read moved that the motion be amended to include instructions to the committee to study the advisability of raising the yearly dues. Mr. Panush accepted the amendment, and the motion as amended was carried.

Yearbook Report: Mr. Luther Shetler, *Yearbook* Editor, distributed copies of the 1956 financial statement of the CASMT *Yearbook*, and was complimented by the Board for his excellent report. He explained that the low figure of $29.47 profit shown in the treasurer's report was due to two checks not yet having reached the treasurer. These checks will bring the net profit to $357.95.

Policy and Resolutions Committee: Mr. Louis Panush reported that the committee had not as yet met and that correspondence was the basis for the tentative report which he submitted. Since the committee was to meet on Friday, it was moved by Read, seconded by Gross, that the report be tabled for consideration at the Saturday Board meeting. Carried.

Membership: Mr. Joseph Kennedy reported both on membership activities and on expenses of the committee. A copy of the former report was filed with the secretary, and a copy of expenses with the treasurer. Mr. Kennedy asked for an opinion on the advisability of continuing or extending his experiment on sending letters to selected individuals to solicit memberships. It was moved by Read, seconded by McCormick, that Mr. Kennedy be authorized to continue his series of letters to prospective members to the same size group as in the past year. Carried.

Constitution Revision Committee: Mr. Wren presented the proposed changes in Article III, carrying out the directions of the 1955 convention to remove discrepancies in the wording. It was moved by Read, seconded by McCormick, that this portion of the report be adopted and that arrangements be made for its publication in two successive issues of the *Journal*. Carried Mr. Wren then presented the plan for the nomination and election of officers. In the discussion of the proposal, the following changes in wording were agreed to: Item 3 to read "It shall be the duty of the Nominating Committee to name two candidates each for the offices of President and Vice President, and twice as many candidates as positions to be filled on the Board of Directors. . . . All nominees must be properly qualified members in good standing of the Association, . . . " Items 4 and 5 were combined into a single item reading in its entirety: "It should be the duty of the Chairman of the Nominating Committee to secure from each nominee a professional biography in time to provide copy for publication in the Yearbook prior to October 15 of the year in which the election is to be held. Ballots shall be mailed to members in good standing of the Association and shall be returned by November 15. No vote postmarked after 12 midnight, November 15, shall be accepted for count. The Yearbook shall carry this information.

It was agreed to insert as sentence 2 of item 6: "In the event either of these cannot serve, the president shall appoint an alternate."

Considerable discussion on item 2 followed. Mr. Read moved, seconded by

Panush, that the Board approve the method outlined in the proposed plans for nomination and election of officers and that the committee bring in to the spring Board meeting proper wording for the sections under discussion. Carried.

Projects and Research Committee: Mr. Vernon Price distributed copies of the report of his committee, which included a committee recommendation for a curricular study, or studies, aimed at determining areas in science and mathematics which need to be improved. It was moved by Wren, seconded by Read, that the chairman be asked to draw up in form suitable for publication in the *Journal* the several topics suggested in the report for research studies and that the committee's recommendation relative to student memberships be submitted to a special committee on memberships. Carried.

The meeting of the Board of Directors was adjourned at 11 P.M.

II. Annual Business Meeting

Saturday, November 24, 1956, Ballroom

President Charlotte Junge called the annual business meeting to order at 10:00 A.M.

It was moved, seconded, and carried that the reading of the minutes of the previous meeting be dispensed with and that the minutes be approved as published in the February 1956 issue of the *Journal*.

In his treasurer's report, Mr. Soliday stated that the apparent deficit of about $231 for the past year was offset by a profit the previous year of about $1300, and mentioned that over a period of years the Association operates on a balanced budget. He urged pre-payment of dues, a year or two in advance, to eliminate expense of soliciting renewals. He reminded the membership that gifts of back numbers of the *Journal* would be welcome for the purpose of filling orders for back issues.

President Junge announced that the changes in wording of the proposed By-Laws referred to the Board of Directors last year by the convention has been made and that publication in two successive issues of the *Journal* would precede balloting on these changes in 1957. She announced further that a proposal for change in the method of conducting elections was being worked out by a committee, and that this proposal would also appear in the *Journal* in time to be considered at the 1957 meeting.

She announced the resignation of Dr. Willard Unsicker from the Board of Directors.

Chicago was announced as the city chosen for the 1957 convention.

The nominating committee, composed of Iva Spangler, Glenadine Gibb, Clyde McCormick, Milton Pella, and Cecelia Lauby, Chairman, presented its report. Speaking for the committee, Miss Lauby mentioned the published notices in the *Journal* and the Yearbook requesting the membership to submit suggestions for nominees, and stressed the committee's efforts to select persons whose service to the Association was outstanding and who represented the various teaching levels, subject areas, and geographic regions. She then presented the following slate for 1957:

President: Edward Bos, Proviso Township High School, Maywood, Illinois
Vice-President: Louis Panush, Northeastern High School, Detroit, Michigan
Board of Directors, terms to expire in 1959:
Glenn Ayre, Western Illinois State College, Macomb, Illinois
Frances Gourley, LaPorte High School, LaPorte, Indiana
Walter Hauswald, Sycamore High School, Sycamore, Illinois
Luther Shetler, Bluffton College, Bluffton, Ohio
Board of Directors, to fill an unexpired term of one year:
Alice Hach, Board of Education, Racine, Wisconsin

Miss Lauby moved that the above slate be placed in nomination. Iva Spangler seconded the motion. President Junge called for nominations from the floor. Mr.

Pella moved that the slate be accepted, the nominations be closed, and that a unanimous ballot be cast. Seconded by John Cowin. Motion carried. The newly elected officers and board members were then introduced.

The president thanked the officers, board members, and various committees who had aided so greatly in carrying out the work of the past year and of the convention.

Miss Lauby called attention to the need for filling the unexpired term on the Board due to the election of Mr. Bos to the presidency. Mr. Panush nominated Lawrence Conrey, University School, Ann Arbor, Michigan; Miss Lauby nominated Howard Michaud, Purdue University. It was moved by Gross, seconded by Cowin, that the nominations be closed. On a vote by a show of hands, Mr. Conrey was declared elected.

Miss Lauby expressed the thanks of the Association to President Junge for her fine work during the past year.

The meeting was adjourned at 10:30.

III. BOARD OF DIRECTORS MEETING

SATURDAY, NOVEMBER 24, 1 P.M., BERWYN ROOM

Roll Call: Bos, Sister Evarista, Gourley, Gross, Hach, Hauswald, Huffer, Junge, Kennedy, McCormick, Otto, Panush, Pella, Read, Shetler, Soliday, Takala, Terhune, Warner, Wren.

President Junge called the meeting to order, and asked for action on appointment of the Association secretary. It was moved by Gross, seconded by Read, that the secretary be reappointed for a term of three years. Carried. It was moved by Gross, seconded by Takala, that the historian not be asked to prepare a report in 1957. Carried.

Mr. Panush, chairman of the Policy and Resolutions Committee, presented the report of his committee, giving the following recommendations to the Board of Directors for consideration and action:

1. That the Board instruct the incoming Policy and Resolutions Committee for 1957 to make a study of the membership composition of the Board for the past ten years and to determine geographical distribution, representation in science and mathematics, and representation according to teaching levels, this study to be presented to the Board at its next meeting.
2. That the Board instruct the 1957 Membership chairman to form a committee comprised of at least one member representing science and one representing mathematics in each state to be responsible for maintaining the membership of our Association.

Read moved, Wren seconded, the adoption of the first resolution. Carried. Read moved, Takala seconded, the adoption of the second resolution. Defeated.

An informal discussion evaluating the convention brought suggestions on the choice of convention hotel, nature of the program, and promotional measures that might increase attendance in the future. Read moved, seconded by Gourley, that the Board convey to the vice-president the ideas expressed concerning a possible revision of the nature of the program. Carried.

On the completion of the old business, Miss Junge thanked the board for the help given in the past year, and turned the chair over to the new president, Mr. Bos. The new Board members were then introduced.

As a first item of new business, Read moved, seconded by Gross, that the River Forest State Bank and Trust Co. be named the depository for the funds of the CASMT. Carried.

With the agreement that the spring meeting of the Board of Directors would be held on April 27, the meeting was adjourned at 2:30 P.M.

Respectfully submitted,
VIRGINIA TERHUNE, *Secretary*

PROBLEM DEPARTMENT

CONDUCTED BY MARGARET F. WILLERDING

San Diego State College, San Diego, Calif.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution or proposed problem sent the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the Department desires to serve her readers by making it interesting and helpful to them. Address suggestions and problems to Margaret F. Willerding, San Diego State College, San Diego, Calif.

SOLUTIONS AND PROBLEMS

Note: Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Solutions should be in typed form, double spaced.

2. Drawings in India ink should be on a separate page from the solution.

3. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

4. In general when several solutions are correct, the one submitted in the best form will be used.

LATE SOLUTIONS

2515, 2525, 2529. *A. R. Haynes, Tacoma, Wash.*

2533. *Proposed by Julius Sumner Miller, El Camino College, California.*

A ball is dropped from a tower at the same instant another of equal mass is projected upward from the bottom of the tower with a velocity just enough to raise it to the top of the tower. Show that if the balls collide centrally the falling ball will rise, on the rebound, to a height $h/4(3+e^2)$ above the ground, where h is the height of the tower and e is the coefficient of restitution.

Solution by the Proposer

Let

t = time of motion before collision.
h_1 = distance *fallen* by upper ball before collision.
h_2 = distance *risen* by lower ball before collision.

Then $h_1 = \frac{1}{2}gt^2$ and $h_2 = V_0t - \frac{1}{2}gt^2$, where V_0 = velocity of projection of lower ball. This V_0 is clearly $\sqrt{2gh}$.

We seek first h_1:

$$h_1 = h - h_2$$

$$\tfrac{1}{2}gt^2 = h - \sqrt{2gh}\cdot t + \tfrac{1}{2}gt^2$$

whence

$$t = \sqrt{\frac{h}{2g}}$$

(which is interesting!).

At once $h_1 = \frac{1}{4}h$. Therefore $h_2 = \frac{3}{4}h$ (another interesting detail!).

Now let us seek the velocities at impact:

From $V_f^2 = V_0^2 \pm 2as$, in general, we have, for the *falling* ball,

$$V_f = \sqrt{\frac{gh}{2}}.$$

$$\left(\text{This could also be gotten from } V_f = gt = g\sqrt{\frac{h}{2g}}.\right)$$

And for the *rising* ball,

$$V_f^2 = 2gh - 2g \cdot \tfrac{1}{4}h = \tfrac{1}{2}gh,$$

whence

$$V_f = \sqrt{\frac{gh}{2}}.$$

We thus learn that the balls have equal velocities (magnitude) at impact. (A *shrewd* observer could have predicted this!)

Now we apply momentum considerations. Since the masses are equal and the velocities at impact equal in magnitude and opposite in direction, $V_2 = -V_1$. That is, the *rebound* velocities are equal in magnitude but opposite in direction. (This we may prove from $m_1\mu_1 - m_2\mu_2 = m_1V_1 + m_2V_2$, in general, where, in our case, $m_1 = m_2$ and $\mu_1 = \mu_2$ (magnitude).)

Also,

$$e = \frac{V_2 - V_1}{\mu_1 - \mu_2}$$

where the V's are relative velocity of separation and the μ's relative velocity of approach.

Then

$$V_1 = -\frac{e\sqrt{2gh}}{2}.$$

Knowing that $V_1^2 = 2gs$, where s = height of rebound of the *falling* ball, we get $s = \frac{1}{4}e^2h$.

The *falling* ball therefore rises to a

$$\text{height above ground} = \frac{3}{4}h + \frac{1}{4}e^2h = \frac{h}{4}(3+e^2),$$

which was to be proved.

Solutions were also offered by Sister Mary Eleanor, Villa Madonna College, Kentucky; and C. W. Trigg, Los Angeles, Calif.

2534. *Proposed by C. N. Mills, Sioux Falls, S. D.*

Given the three points (0, 0), (0, 4), and (3, 0). Using Ptolemy's Theorem show that the equation of the circumcircle is

$$x^2 + y^2 - 3x - 4y = 0.$$

Solution by W. R. Talbot, Jefferson City, Mo.

Let the given points (0, 0), (3, 0), (0, 4), and the general point (x, y) be designated by A, B, D, and C respectively. Ptolemy's Theorem states that

$$AB \cdot CD + BC \cdot AD = AC \cdot BD. \tag{1}$$

With $AB = 3$, $AD = 4$, and $BD = 5$, (1) reduces to

$$3CD + 4BC = 5AC.$$

Squaring both sides and making the following substitutions:

$$(AC)^2=x^2+y^2 \qquad (CD)^2=x^2+y^2-8y+16 \qquad (BC)^2=x^2+y^2-6y+9,$$

we get

$$CD\cdot BC=3y+4x-12.$$

Squaring both sides again, we get

$$(x^2+xy^2-8y+16)(x^2+y^2-6x+9)=9y^2+16x^2+144+24xy-72y-96x.$$

This expands and collects to the square of

$$x^2+y^2-3x-4y=0.$$

This is the condition that the four points be inscriptible.

Solutions were also offered by Herta T. Freitag, Hollins College, Va.; A. R. Haynes, Tacoma, Wash.; and C. W. Trigg, Los Angeles, Calif.

2535. *Proposed by Julian H. Braun, San Diego, California.*

Suppose P is the probability that at least one door of a four door automobile has a defective lock. Show that the probability of exactly two doors having defective locks is given by

$$\frac{3}{8}P^2\left(1+\frac{1}{4}P+\cdots\right).$$

What is the probability that exactly one door will have a defective lock?

Solution by the Proposer

Let X_2 be the probability that exactly 2 doors will have defective locks and let p be the probability that a lock in a door chosen at random is defective. Since P is given by subtracting the probability of no doors being defective from unity we have

$$P=1-(1-p)^4. \tag{1}$$

There are 6 ways of selecting a combination of 2 things from a group of 4. Therefore, we have

$$X_2=6p^2(1-p)^2 \tag{2}$$

From (1) we obtain

$$p=1-(1-P)^{1/4}$$

which expanded by the Binomial Theorem yields

$$p=\frac{1}{4}P\left(1+\frac{3}{8}P+\frac{7}{32}P^2+\cdots\right).$$

Substituting this result in (2), expanding, and simplifying, yields

$$X_2=\frac{3}{8}P^2\left(1+\frac{1}{4}P+\cdots\right).$$

Similarly, we obtain

$$X_1=4p(1-p)^3=P\left(1-\frac{3}{8}P-\frac{5}{32}P^2-\cdots\right).$$

A solution was also offered by W. R. Talbot, Jefferson City, Mo.

2536. *Proposed by N. Kailasamaiyer, Madras, India.*

Given triangle ABC. Equilateral triangles are described on the sides externally. If x, y and z are the orthocenters of the equilateral triangles, show that xyz is an equilateral triangle.

Solution by C. W. Trigg, Los Angeles City College

Represent the sides and angles of ABC in the conventional manner, and let the orthocenters (and hence, the centroids) of the equilateral triangles on a, b, c be x, y, z, respectively. Then we have immediately:

$$Bz=c/\sqrt{3}, \quad Bx=a/\sqrt{3}, \quad \text{and} \quad \sphericalangle zBx=\beta+60^\circ.$$

Now

$$\operatorname{Cos}\beta=\frac{a^2+c^2-b^2}{2ac} \quad \text{and} \quad \sin\beta=\frac{\sqrt{2(a^2b^2+b^2c^2+c^2a^2)-a^4-b^4-c^4}}{2ac}.$$

Furthermore,

$$\cos(zBx)=\cos(\beta+60^\circ)=\tfrac{1}{2}\cos\beta-\tfrac{1}{2}\sqrt{3}\sin\beta.$$

Then

$$(zx)^2=(Bz)^2+(Bx)^2-2(Bz)(Bx)\cos(\beta+60^\circ)$$

$$=\frac{c^2}{3}+\frac{a^2}{3}-\frac{2ca}{3}\left(\frac{a^2+c^2-b^2-\sqrt{3}\sqrt{2(a^2b^2+b^2c^2+c^2a^2)-a^4-b^4-c^4}}{4ac}\right)$$

$$=\tfrac{1}{6}\left[a^2+b^2+c^2+\sqrt{3}\sqrt{2(a^2b^2+b^2c^2+c^2a^2)-a^4-b^4-c^4}\right].$$

Now zx was arbitrarily chosen for evaluation, and this evaluation is symmetrical in a, b, c. Hence $zx=xy=yz$, and xyz is equilateral.

This and other properties of this popular configuration have appeared in SCHOOL SCIENCE AND MATHEMATICS, *9*, 68, 300, (1909); *13*, 728, (1913); *14*, 64, 723, (1914); *18*, 170, (1918); *19*, 86, 374, (1919); *22*, 677, (1922); *25*, 979, (1925); *28*, 997, (1928); *40*, 84, 386, (1940); *42*, 797, (1942); *43*, 480, (1943); *49*, 501, (1949).

Solutions were also offered by Leon Bankoff, Los Angeles, Calif.; Herta T. Freitag, Hollins College, Va.; A. R. Haynes, Tacoma, Wash.; W. R. Talbot, Jefferson City, Mo.; and the Proposer.

2537. *Proposed by A. R. Haynes, Tacoma, Wash.*

In triangle ABC, show

$$\cot A+\cot B+\cot C=\frac{1}{2}\left[\frac{\sin A}{\sin B\sin C}+\frac{\sin B}{\sin C\sin A}+\frac{\sin C}{\sin A\sin B}\right].$$

Solution by Cecil B. Read, University of Wichita, Wichita, Kan.

The mathematician often prefers to solve a problem by reducing it to one previously solved. Problem 2257, proposed June, 1951, solved December, 1951 proves that if

$$A+B+C=180^\circ,$$

then

$$\cot A+\cot B+\cot C=\cot A\cot B\cot C+\csc A\csc B\csc C.$$

Comparing the right hand members of the identities of problems 2257 and 2537, after reducing to a common denominator, it is evident the solution of 2537 will be valid if we can prove

$$\sin^2 A+\sin^2 B+\sin^2 C=2[\cos A\cos B\cos C+1].$$

Now

$$B+C=180^\circ-A$$

hence

$$\cos (B+C) = -\cos A$$
$$\cos B \cos C - \sin B \sin C = -\cos A$$

from which

$$[\cos A + \cos B \cos C]^2 = [\sin B \sin C]^2$$
$$= (1-\cos^2 B)(1-\cos^2 C)$$

which reduces to

$$\cos^2 A + 2 \cos A \cos B \cos C = 1 - \cos^2 B - \cos^2 C$$

or

$$2 \cos A \cos B \cos C = 1 - \cos^2 A - \cos^2 B - \cos^2 C$$
$$= \sin^2 A + \sin^2 B + \sin^2 C - 2.$$

Solutions were also offered by Mary Ball, Hartford, Conn.; Felix John, Philadelphia, Pa.; W. R. Talbot, Jefferson City, Mo.; C. W. Trigg, Los Angeles, Calif.; Walter R. Warne, St. Petersburg, Fla.; Frank Weber, Pasadena, Calif.; and the Proposer.

2538. *Proposed by Brother Felix John, Philadelphia, Pa.*

Find the condition, among its coefficients, that the expression

$$ax^4 + 4bx^3y + 6cx^2y^2 + 4dxy^3 + ey^4$$

should be reducible to the sum of the fourth powers of two linear expressions in x and y.

Solution by the Proposer

1. Let the given expression be identically equal to $(px+qy)^4 + (rx+sy)^4$. Equating the coefficients of like powers:

$$p^4 + r^4 = a \tag{1}$$
$$p^3q + r^3s = b \tag{2}$$
$$p^2q^2 + r^2s^2 = c \tag{3}$$
$$pq^3 + rs^3 = d \tag{4}$$
$$q^4 + s^4 = e \tag{5}$$

2. Equation (1) times equation (3), minus the square of equation (2) gives

$$(p^2rs - pqr^2)^2 = p^2r^2(ps-qr)^2 = ac - b^2 \tag{6}$$

3. Equation (3) times equation (5), minus the square of equation (4) gives

$$(pqs^2 - rsq^2)^2 = q^2s^2(ps-qr)^2 = ce - d^2 \tag{7}$$

4. Equation (2) times equation (4), minus the square of equation (3) gives

$$pqrs(p^2s^2 - 2pqrs + q^2r^2) = pqrs(ps-qr)^2 = bd - c^2 \tag{8}$$

5. Since, by inspection, the product of equations (6) and (7) equals the square of equation (8):

$$(ac-b^2)(ce-d^2) = (bd-c)^2 \quad \text{or} \quad ace - ad^2 - b^2e + 2bcd - c^3 = 0.$$

A solution was also offered by A. R. Haynes, Tacoma, Wash.

STUDENT HONOR ROLL

The Editor will be very happy to make special mention of classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each student contributor will receive a copy of the magazine in which his name appears.

EDITOR'S NOTE: This department has a need for some new and interesting proposals. Please send in some problems to the Editor.

PROBLEMS FOR SOLUTION

2557. *Proposed by John Satterly, Toronto, Canada.*

In any triangle ABC, if G is the centroid, I the incenter, R the circumradius and r the inradius, prove $GI^2 = 1/3\ (bc+ca+ab) - 1/9\ (a^2+b^2+c^2) - 4Rr$.

2558. *Proposed by A. R. Haynes, Tacoma, Wash.*

Using the relation $e^{ix} = \cos x + i \sin x$, show

$$e^{-\pi/2} = i^i \tag{1}$$

$$e^{\pi} = i \tag{2}$$

$$e^i = i^{1/\pi} \tag{3}$$

$$\pi = -2 \log i^i. \tag{4}$$

2559. *Proposed by Vincent C. Harris, San Diego, Calif.*

What is the locus of a point such that the angle subtended by a fixed segment is constant?

2560. *Proposed by Julius Sumner Miller, El Camino, Calif.*

A wheel is rolling uniformily along a horizontal road. Is there any point of the rim which has a velocity which is straight up or straight down?

2561. *Proposed by Brother Felix John, Philadelphia, Pa.*

A certain number is the product of three prime factors, the sum of whose squares is 2331. There are 7560 numbers (including unity) which are less than the number and prime to it. The sum of its divisors (including unity) and the number itself) is 10,560. Find the number.

2562. *Proposed by Hugo Brandt, Chicago, Ill.*

If

$$a\sqrt{(s-a)^2 - b(2s-b)} = (a+s)^2$$

and

$$b\sqrt{(s-b)^2 - a(2b-a)} = (b+s)^2$$

show that

$$ab = s^2 \text{ if } a \neq b.$$

TYPES OF SCIENTISTS NEEDED

Almost every kind. Physicists are needed to do basic research on the underlying facts of nature; we have nearly exhausted our present store of basic research. Mathematicians are necessary to predict neutron behavior. Chemists must search out better methods for processing fission products. Metallurgists must determine materials that can withstand the incredible heat and stress involved in atom-splitting. Medical men and biochemists must ascertain the effects the atom can have on health. Biologists and agronomists must seek methods by which the atom can improve crops. Engineers of every variety—mechanical, civil, electrical, metallurgical, mining, to mention a few—are equally essential. They must translate the broad findings of the scientists into practical usage.

—L. R. HAFSTAD, *Vice President of General Motors*

BOOKS AND PAMPHLETS RECEIVED

ALGEBRA AND ITS USE, Book II, by Ethel L. Grove, *Formerly Cuyahoga Heights High School, Cleveland, Ohio;* Anne M. Mullikin, *Germantown High School, Philadelphia, Pennsylvania;* and Ewart L. Grove, *University of Alabama, University, Alabama.* Cloth. Pages iv+538. 15×23 cm. 1956. American Book Company, 55 Fifth Avenue, New York 3, N. Y. Price $3.40.

DICTIONARY OF ANTHROPOLOGY, by Charles Winick. Cloth. Pages vii+579. 13.5×21 cm. 1956. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $10.00.

INTERMEDIATE ALGEBRA, by William G. Shute, *Instructor in Mathematics, The Choate School, Wallingford, Connecticut;* William E. Kline, *Supervisor of Testing, Board of Education of Baltimore County, Towson, Maryland;* William W. Shirk, *Instructor in Mathematics, The Choate School, Wallingford, Connecticut;* and Leroy M. Willson, *Associate Professor of Mathematics, Georgia State College of Business Administration, Atlanta, Georgia.* Cloth. Pages ix+486+xxxvi. 14×22 22 cm. 1956. American Book Company, 55 Fifth Avenue, New York 3, N. Y. Price $3.40.

THE OSCILLOSCOPE AT WORK, by A. Haas and R. W. Hallows, M. A. Camtab., M.I.E.E. Cloth. 171 pages. 13.5×21.5 cm. 1956. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $10.00.

NEW ERA OF FLIGHT, AERONAUTICS SIMPLIFIED, by Lewis Zarem and Robert Maltby. Cloth. 176 pages. 16×24 cm. 1956. E. P. Dutton and Company, Inc., 300 Fourth Avenue, New York 10, N. Y. Price $3.75.

ELECTRONIC TUBES, CIRCUITS, AND DEVICES, by Lewis G. Blevins, Paper. 59 Experiments. 20.5×28 cm. 1956. Universal Scientific Company, Inc., 1102 Shelby Street, Vincennes, Ind.

TEACHER'S GUIDE AND ANSWERS FOR THE SCRIBNER ARITHMETIC, Book 4, by Richard Madden, Leslie S. Beatty, and William A. Gager. Paper. 93 pages. 22.5×30 cm. 1956. Charles Scribner's Sons, 597 Fifth Avenue, New York 17, N. Y. Price $2.20.

GENERAL MENTAL FUNCTIONS ASSOCIATED WITH DIVISION, by Henry Van Engen, and E. Glenadine Gibb. Paper. Pages ix+181. 15×23 cm. 1956. Iowa State Teachers College, Cedar Falls, Iowa.

TEACHERS OF CHILDREN WHO ARE PARTIALLY SEEING, Prepared by Romaine P. Mackie and Edith Cohoe. Bulletin 1956, No. 4. Pages viii+71. 14.5×23 cm. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 30 cents.

BOOK REVIEWS

CHEMISTRY IN ACTION, Third Edition by George M. Rawlins, *Professor of Chemistry, Austin Peay State College, Clarksville Tenn.* and Alden H. Struble, *late teacher of Chemistry, Western High School, Washington, D. C.* Cloth, Pages viii+591. 16×23.5 cm. 1956, D. C. Heath and Co. Boston 16, Mass. Price $4.40.

This is the third edition of a widely used high school text book in general chemistry. The logical order of presentation of the previous editions have been kept. The book is well constructed, print is easily read, and color has been used to a good advantage in making the many illustrations vivid.

The subject of organic chemistry has been approached in an interesting and

practical fashion. Around 100 pages is devoted to organic chemistry and its many every day applications.

And excellent set of summary questions and problems is found at the end of each chapter along with an up to date reference list. The appendix includes an excellent bibliography, a list of useful films and a glossary of terms. Accompanying the text is a Teacher's Handbook, containing answers to all questions and problems in the text.

The book should be teachable for the average high school student and I believe it lives up to the authors' statement in their preface, namely, they "believe that it is a thorough, one-year course and that the mastery of the subject matter included will not only prepare one to pass a college entrance examination but will enable one to understand and enjoy your environment much more fully."

GERALD OSBORN
Western Michigan College
Kalamazoo, Michigan

MODERN BIOLOGY, by James H. Otto, *Head of the Science Department, George Washington High School, Indianapolis, Indiana;* Truman J. Moon *was Head of the Science Department High School, Middletown, New York;* and Paul B. Mann *was Head of the Biology Department in Evander Childs High School, New York City.* Cloth. Pages x+757. 15.5×23.5 cm. 1956. Henry Holt and Company, 383 Madison Avenue, New York 17, N. Y. Price $4.88.

This book has been completely revised with some reorganization, rewriting of some sections and addition of new material. This is truely a revision of what was considered a good high school biology textbook.

Many changes include the use of color through out the book to stimulate interest as well as helps in bringing out important points and details of biology. Most of the good points of the earlier editions have been retained.

In the previous edition by the use of the "Trans-vision" process, the human torso is shown in detail. This is again included. By the use of the same process an equally good study is made of the frog.

Each chapter opens with a general paragraph to help set the stage for what is to come. These seem to be good. They are written in an understandable way with items included that are of interest to high school students.

Much of the context has been written for easier reading with some unnecessary materials omitted. The general style has more appeal to the reader.

The general organization remains essentially the same. Some chapter headings have been dropped and some chapters have been divided by shifting materials. This all permits a greater flexibility in the use of the book. Even though there is a definite presentation of units the sequences are so that adjustments can be made to any teaching situation.

This is one of the better high school biology textbooks combining the best features of the type, systematic and principles of biology. It includes a wealth of material in a way that is meaningful and can be adapted to any teaching method. Presentation is interesting with much thought having been given to the teacher and the student that will be using the book.

Like many of the present textbooks the size has been increased along with additional pages. There is more material than any one course can adequately cover in a year course. We can always select what we want. Textbooks large in size become a problem for students to carry.

NELSON L. LOWRY

PLANT PHYSIOLOGY, Fourth Edition, Revised, by Meirion Thomas, M.A., F.R.S., F.R.S.E., *Professor of Botany at King's College, Newcastle upon Tyne, in the University of Durham.* Cloth. Pages xii+692. 13×21.5 cm. 1956. Philosophical Library, Inc., 15 East 405 Street, New York 16, N. Y. Price $12.00.

A book for use by the advanced student of science that has had a course in general botany at the college or university level with some chemistry and physics.

Attention is confined to an analysis of the principle physiological processes that occur in green plants. Little attention is given to the physiology of development with physiology of reproduction being omitted.

There are many references to modern literature and articles in current periodicals related to plant physiology. References are used as a source of information where more complete and original information can be found.

A few charts, tables and diagrams are used to help illustrate pertinent facts. More would help to give the reader with only a knowledge of general botany a better understanding of what is being discussed.

The author has included many of the never concepts of plant physiology of green plants as they are related to chemical and physical changes. The discussions related to chemical activity with the plant and plant processes has been greatly increased over the earlier edition of the book in 1947. Information now thought to be outdated has been excluded from the present edition.

The appendix is divided into three useful sections dealing with chemistry of metabolic products, physical chemistry, and special chemical and physical techniques. Reference is made to use of tracer atoms and tracer techniques in the study of plant processes.

This book can serve as a good reference work for advance studies in physiology of plants as related to botany, chemistry, agriculture and other related sciences.

NELSON L. LOWRY

PLANE GEOMETRY, by Rolland R. Smith and James F. Ulrich, with the cooperation of John R. Clark. World Book Company, Yonkers-on-Hudson, New York. vii plus 536 pages. Price $3.84.

The basic aims of this text are stated to be, "to teach demonstrative geometry as a system of reasoning, emphasizing the development of logical thinking, and, to build practical understanding of the principles and uses of geometry."

Let us examine some procedures employed by the authors to achieve these aims. There is an introductory section which leads from the known to the unknown. The student begins with conclusions drawn from measurements and is lead into conclusions based on relations without measurement.

Chapter 4 deals with "The Nature of a Geometric Proof." Students are introduced first to the three congruency cases S.A.S., A.S.A., and S.S.S. by construction (without a formal demonstration). More and more teachers of geometry adopt this procedure. These 3 cases are then used as a basis for reasoning.

On page 70, is a good list of exercises entitled, "Are the Triangles Congruent Under the Conditions Given."?

We should mention the effective use of red color to serve as a teaching aid. For example: color makes a visual distinction between hypothesis and conclusion.

While the type and format are good, the first 62 pages leave an impression of excessive wordiness. The average high school sophomore dreads pages and pages of mathematical reading material.

On page 65 some needed construction arcs are missing.

A good list of "restated definitions and their reverses" is found on page 76, however the adoption of two distinct definitions for perpendicular lines is bad.

The first formal treatment of proof of theorems is given on page 103. Many teachers prefer that all auxiliary lines be introduced as statements and supported by reasons in the proof itself. No step should be left open to challenge.

On page 114, Case h.a. = h.a. is introduced: "If two right triangles have the hypotenuse and an acute angle . . . etc." Wouldn't it be better to substitute the word "adjacent" for "acute"? The latter implies a need to prove the adjacent angle is also an angle which is less than a right angle and more than a zero degree angle. The Summary of methods for proving two lines equal, two angles equal, etc., on page 123 is excellent.

The "geometry of three dimensions" on page 132, to page 224, etc., is classified as "optional," but probably should be assigned in most schools, since many do not offer Solid Geometry any more.

Beginning teachers will welcome the fact that the following statements are classified as *postulates* on page 140 to page 149; "If two straight lines are cut by a transversal so that two alt. int. angles are equal, the lines are parallel." "Two lines perpendicular to a third line,—are parallel." "If a line is perpendicular to one of 2 parallel lines, it is perpendicular to the other also." "If two parallel lines are cut by a transversal, the alt. int. angles are equal." Page 156 the discussion on "Non Euclidean Geometry" is well done, as is the "Necessary and Sufficient Conditions," lecture on page 181.

On page 253 are some proofs taken from students' papers, which show false reasoning. Pupils are asked to detect the errors in each proof. More exercises of this type should be included in modern geometry texts.

Finally on page 495, Chapter 19 is devoted to "Deductive Reasoning in Non-Geometric Situations." Many teachers of geometry would prefer to have more non-geometric materials, such as simple syllogisms, introduced much earlier in the course than page 199 or page 495. But an author can't do everything. In fact, many parents will object to paying $3.84 for a high school geometry text. Maybe if a teacher can sell the community on the idea that this text, also includes the price of a text in Solid Geometry, the objections will be less. Personally, I believe it's worth the money. The excellent paper, the attractive cover, the wealth of material included will make this a text which will be seriously considered by text book committees.

A. S. RICHERT
East High School
Wichita, Kansas

LECTURES ON THE ICOSAHEDRON AND THE SOLUTION OF EQUATIONS OF THE FIFTH DEGREE, by Felix Klein. Translated by George Gavin Morrice, M.A., M.D. Second and Revised Edition. Paper. Pages xvi+289. 14×20.5 cm. Dover Publications, Inc., New York 10, N. Y. Price $1.85.

This volume, published originally in 1888, appearing as a second edition in 1913, and now available for the first time in many years, is a well-known classic in mathematics. As an undergraduate, this reviewer was intrigued by a statement of one of his professors to the effect that there could be a relationshlp between the geometric figure of the icosahedron and the algebraic problem of solving a certain equation. Reference to this book quickly made it aware that more mathematical maturity was needed than was then possessed. This statement is still true. The book involves such topics as elliptic functions; the theory of groups; functions of a complex variable; homogeneous point coordinates—to mention only a few. There is an interesting portion on the historical development of the theory of equations of the fifth degree. A classic such as this work really needs no comment.

Probably the most important thing to be noted here is that the book is now available. The publishers are to be congratulated in their endeavour to make this and other classics available at a moderate price. In some cases the sale may not be great, this by no means renders the service less valuable. Certainly any college or university library which has not been able to place this work on the shelves should now avail themselves of the opportunity.

CECIL B. READ
University of Wichita

CRYPTANALYSIS, A STUDY OF CIPHERS AND THEIR SOLUTION, by Helen Fouche Gines. Paper. Pages vi+237. 14×21.5 cm. 1956. Dover Publications, Inc., 920 Broadway, New York 10, N. Y. Price $1.95.

There is little, if any, mathematical theory in this book. Nevertheless, it is a book which goes beyond the usual elementary treatment of "secret ciphers" found in most high school, college, or public libraries. The treatment is extensive enough so that probably none but the true "fan" will read the entire book. This subject is one which seems to attract the interest of young and old. The reviewer

predicts that if the book is placed in a school library, there will be a considerable number of students who will be highly pleased. Probably at first the readers will be concerned with the construction of secret messages, gradually they will proceed to the attempt to "decrypt" or solve a message prepared by another.

The treatment distinguishes between codes and ciphers; between deciphering (reading a message when the key is known) and decrypting (reading a message with no previous knowledge of the key or method). There is brief discussion of concealment ciphers, and much more detail on transposition ciphers and substitution ciphers. There are extensive treatments of various ciphers of a special nature, with hints as to methods of solution. The appendix contains tables and charges giving various percentages and relative frequencies, valuable in decrypting.

There are more than 150 examples of ciphers to be solved, arranged at the end of most of the chapters. These range from quite simple types to those of sufficient difficulty to even challenge the semi-professional. This Dover reprint of the book originally entitled "Elementary Cryptanalysis" contains solutions to the examples (not in the original). Whether or not this is an improvement probably depends on the will power of the reader—how long can he stand the strain of being unable to find the message yet know it is printed in the back of the book? This book is strongly recommended as an addition to any school library—and in many cases the individual teacher or student will be glad to have it on his own shelves.

CECIL B. READ

ABACS OR NOMOGRAMS, by A. Giet, *Ecole Nationale des Ingénieurs Arts et Métiers, Paris.* Cloth. Pages ix+225. 13.5×21.5 cm. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $12.00.

This is a translation, for British readers, of a French text. The reader in the United States may be disturbed by the presence of foreign measurements and nomenclature; this is a minor item. The treatment is primarily "practical," at time verging on the "cook-book" style of presentation. Primary emphasis is upon the construction of nomograms for the evaluation of specific types of formulas, rather than on underlying mathematical principles. At times, the treatment seems unnecessarily repetitious.

The author defines and presents many examples of a Cartesian "abc," which is essentially a rectangular Cartesian coordinate system, and a family of curves each representing a specific value of a third variable. He discusses the advantages of selecting scales for the x- and y-axes so that the z-curves will be straight lines if possible. Contrasted with this scheme he presents the alignment chart, in which two variables are represented respectively on two parallel scales, and a third variable is represented on another scale, which in many, although not all cases, can be represented on a scale parallel to the other two. An appendix discusses briefly the advantages and disadvantages of various methods, with suggestions for the choice of a type of alignment chart.

The more advanced portions discuss alignment charts with curved scales; those with linear but non-parallel scales; charts for three, four, or more variables; double alignment charts.

This book may be valuable as a reference for those desiring to investigate the possibility of evaluation of formulas by the methods outlined. In the opinion of this reviewer, it would not serve as a text in the theory of nomograms. Moreover, the price seems excessively high for the material presented.

CECIL B. READ

FIRST COURSE IN ALGEBRA FOR COLLEGES, by L. J. Adams, *Santa Monica City College, Santa Monica California.* Pages vii+217. 14×21 cm. 1955. Henry Holt Company, 257 4th Avenue, New York, New York. Price $3.00

This book is designed for college freshmen who have never had any courses in algebra. It can serve a two-fold purpose. Namely, a terminal course or a preparatory course.

According to the author, the book is developed along three lines. First, it stresses the meanings of algebraic concepts and processes. Second, there is an emphasis on the fundamental principals such as the use of axioms to solve equations. Third, there is an effort to exhibit the application of alegbra to geometry, science, and the mathematics of business in order to illustrate the usefulness of algebra as a tool in other subject fields.

The reviewer feels the book fulfills the designs of a terminal course in that each topic is treated in such a manner as to give the student a good working knowledge of algebra.

If the book is to be used as a preparatory course, it would be advisable to follow this course with one in intermediate algebra.

There seems to be a lack of "stage setting" for each new topic. That is, the author makes an opening stagement, proceeds with an illustrative example, and this is followed with an abundance of exercises. This procedure seems plausible if it were to serve only as a terminal course. However, it seems as if a more lengthy introduction for each new topic with respect to explanations of needs by illustrations might be advisable. This would, it seems to the reviewer, give the student who is preparing to go further a clearer picture of the part algebra will play in the future courses.

The book covers very adequately the first and second of the author's proposed purposes in that it stresses very fully the meanings of algebraic concepts and processes and the uses of the fundamental principals. There are approximately 2,900 drill problems and nearly 300 written problems to give the student a sufficient amount of practice.

The third purpose, that of exhibiting the application of algebra to geometry, science, and the mathematics of business, seems to have been neglected to a certain degree. The reviewer feels with only approximately 20 pages of the 217 and about 100 problems of the nearly 3,200 devoted to this it could hardly be listed as one of the main purposes.

The reviewer concludes the book could probably serve equally well for a terminal course or a preparatory course and the book sufficiently covers the meanings of algebraic concepts and processes and the use of axioms in solving equations.

JOHN J. RAY
University High School
Bloomington, Indiana

ATOMIC SCIENCE

At the spearhead of human knowledge is atomic science. Since 1939 it has raised from zero an industry we now reckon in billions of dollars, an industry based on something no one ever will see, the neutron, a little part of the atom.

This unseen portion of matter is a monument to man's intellect—something that materialized out of creative, disciplined imagination. Once pure theory, today it is an immense reality, a tremendous force for good.

What atomic science will do for tomorrow's world I would hesitate to predict, although much of my lifetime as a physicist has been spent helping to find both military and civilian uses for this new form of power. But I can say this emphatically. Its future is unlimited.

—L. R. HAFSTAD, *Vice President of General Motors*

Clay Masonry facing material can be attached to existing interior or exterior walls without structural remodeling. The three-quarter-inch-thick slab of hard-burned, Norman-size brick, soon to be on the market nation-wide, is fire-resistant, insect-proof and an insulator in both warm and cold weather.

GEOPHYSICISTS IN ANTARCTICA

The barren white world of Antarctica has closed around two University of Wisconsin-trained geophysicists. For more than a year, in that coldest place on earth, they will be isolated from American homes and friends, without even the solace of mail, but both men were eager for the venture.

This is not so surpassing since to be chosen among the scientists who will carry out the 40-nation program of earth studies called the International Geophysical Year is to be acclaimed especially fitted for their task.

"The old-time polar expedition boys pushed in and got the big pleasure from being there first," Ed Thiel of Wausau, Wis., said as he prepared to leave the Wisconsin campus on the first leg of the Antarctic project. "Of course we'll also get in where no man has ever set foot before, but our greatest satisfaction will be in what we put in our notebooks."

Thiel, who earned his Ph.D. in geophysics from Wisconsin in 1955, signed on as chief seismologist for the American party headed for the Weddell Sea, bordering the east coast of Antarctica. John Behrendt of Stevens Point, UW graduate student, is accompanying Thiel as assistant seismologist. Through gravity, magnetic and seismic measurements indicating changes in subsurface masses, the Wisconsin pair will learn more about the ice-covered earth crust at this southern end of the globe.

SPEND A SUMMER AT STANFORD

High school mathematics teachers will have the opportunity to study new aspects of their subject and its applications in science and industry under a summer fellowship program established at Stanford University by the General Electric Company.

President Wallace Sterling of Stanford said 50 fellows will be selected by the University from high school faculties in 14 western states.

The General Electric Company will pay all expenses, including transportation, board and room, tuition, and fees. Instruction will begin late in June and last six weeks.

"The program is intended to deepen the knowledge of mathematics teachers in our high schools and increase their awareness of the role their subject takes in contemporary civilization," Dr. Sterling said.

"It is hoped they will transmit their new knowledge and interest to their students and will influence many of them to seek careers in mathematics. In view of the serious shortage of mathematicians, this would be a valuable result of the program."

Professor Paul W. Berg of Stanford's Mathematics Department will direct the program for teachers from Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, North Dakota, Oregon, South Dakota, Utah, Washington, and Wyoming.

In addition to classroom work, the fellows will take field trips to General Electric laboratory and manufacturing facilities in the San Francisco Bay Area where they will see mathematics being put to work.

Stanford mathematics professors will teach regular classes. Special lectures will be given by General Electric management, scientific, and engineering personnel.

Three courses will be given. The first will broaden the teacher's background by giving him a working knowledge of number theory, projective geometry and other fields bordering on high school subjects and the second will deal with fundamental concepts of the calculus.

The third, a seminar in the philosophy and methods of problem solving, will enable the teacher to challenge the curiosity of his students and develop in them a scientific frame of mind.

Stanford's is the sixth summer fellowship program, the first in a western university, to be established by General Electric Educational and Charitable Fund for high school teachers of mathematics, chemistry, or physics in major U. S. universities. Three hundred fellows from 38 states and the District of Columbia will participate next summer. In the 13 years through 1957, the program will have enrolled 1900 high school teachers.

The company's total educational support will again approximate $1,500,000 in 1957, according to Kenneth G. Patrick, manager of educational relations. In addition to summer fellowship programs, this will finance graduate fellowships, loans, scholarships, equipment for laboratories, the corporate alumnus program under which alumni contributions are matched dollar for dollar, and other grants.

Applicants for the Stanford summer program must be experienced secondary mathematics teachers who intend to remain in the profession. They must hold at least a bachelor's degree, including undergraduate preparation in mathematics. Full information and application blanks will be distributed by the University to high schools in the 14 states in January.

FEDERAL FUNDS FOR EDUCATION

Federal support for 81 educational programs totaled more than $1.6 billion during the 1954–55 school year, according to a new biennial report of the Office of Education, Department of Health, Education, and Welfare.

Entitled "Federal Funds for Education," the new publication also lists many available statistics for the 1955–56 school year and for several earlier years. Values of commodities and services as well as funds are included in the tabulations.

The new total of $1,616,654,000 is less than half of the 1948–49 sum, which was $3,500,817,000. A significant factor in the decrease was veterans' education and training. Federal support of this program was $2,700,184,000 in 1948–49, or about four times the amount for 1954–55.

A significant increase in Federal assistance for school construction in federally affected areas is shown. Whereas $122,767,000 was expended for this program in 1954–55, only $2,956,000 was disbursed four years earlier. The affected areas include districts in which Federal ownership of property has reduced taxable valuations appreciably, or Federal activities have caused burdensome school enrollments through the influx of workers and their families.

Copies are available at 60 cents each from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

COLLEGE ENROLLMENTS

Record enrollments of freshmen, graduate students, and all nonveteran college students are reported in a new survey by the Office of Education, Department of Health, Education, and Welfare. Data from 1,871 institutions is included in the report, "Statistics of Higher Education: Faculty, Students, and Degrees, 1953–54." The report also shows an unprecedented number of doctoral degrees granted, an increase in the number of institutions with 5-figure enrollments, and continuation of many very small colleges.

The 2,535,000 resident college students were 140,000 fewer than in the record year of 1949–50 when many military veterans were enrolled. However, the 1953–54 enrollment included a record 2,180,843 nonveterans. One in every 74 persons in the United States was a resident college student, compared to one in 88 in 1939–40. The first Office of Education report on higher education, in 1869–70, showed a ratio of only one in 740. In the 18–21 age category, one person in four was a resident college student. The proportion in 1939–40 was one in five, and in 1899–1900, one in twenty-five. About half of the high school graduates from the previous year entered college in 1953–54. Twenty years earlier, 35% enrolled. One in every nine resident college students was doing graduate work, the publication notes. By contrast, the ratio was 1 in 14 in 1939–40 and 1 in 23 in 1929–30. More doctoral degrees—nearly 9,000—were conferred in 1953–54 than ever before. Fifty-five%—a new high—of the total college enrollment was in publicly controlled institutions. Long-term trends include virtual disappearance of city and county normal training schools, and rapid growth of junior colleges from 46 listed in the 1917–18 report to 498 in 1953–54.

The survey report was prepared by Henry G. Badger, and Mabel C. Rice, of the Research and Statistical Services Branch, Office of Education. The publication can be obtained for 45 cents from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

Second Revised Edition!

LIVING CHEMISTRY

AHRENS • BUSH • EASLEY

- completely up-to-date content
- a new final unit, "Nuclear Science in a Changing World"
- new information on increasing the volume of rainfall by chemical means
- new material on plastics, additional material on some important metals
- new material on the Salk vaccine
- many new illustrations and descriptive drawings

send for full information to

GINN AND COMPANY Home Office: Boston Sales Offices:
New York 11 Chicago 6 Atlanta 3 Dallas 1 Columbus 16 San Francisco 3 Toronto 7

A persuasive introduction to SCIENCE for High School Students

by Painter and Skewes

AMERICA NEEDS MORE SCIENTISTS—and one way to get them is to attract—and hold—the interest in science studies of the high school freshman. But, many youngsters are poor readers, and are discouraged by the vocabularies and concepts of textbooks. The authors of GENERAL SCIENCE FOR HIGH SCHOOL—a 1955-revision of a popular textbook—have emphasized simplicity of language and approach, to help win more students to this rewarding and critical profession. The publishers have contributed by making the book modern and attractive in design and binding. It is one of three textbooks awarded the Certificate of Excellence by The Society of Typographical Arts, 1956. See also:

***Study Guide and Manual* and separate Test Booklet by the same authors.**



Mentzer, Bush and Company
330 East Cermak Rd., Chicago 16

Ready in April—

New Second Edition of these trail-blazing algebra texts —

Algebra: Its Big Ideas and Basic Skills Books I and II

by Daymond J. Aiken
Kenneth B. Henderson
and Robert E. Pingry

These new books, as before, are organized around the big ideas and basic skills of algebra, giving direction to the subject and making it understandable and meaningful to students. Effective cartoons, diagrams, charts, and graphs, most in two colors, motivate new ideas, provide interest, and focus attention on key steps. The new 1957 Edition offers for each book:

- **Over 7000 problems and exercises that provide ample practice**
- **Many new verbal problems drawn from all areas, that point up the significance of algebra in everyday life**
- **New and varied study aids and self tests**
- **Two colors throughout and many new illustrations**
- **Teacher's Manual and Key and Test Booklet**

Write for descriptive material

McGraw-Hill Book Company, Inc.

New York 36 Chicago 30 Dallas 2 San Francisco 4

Open It and LOOK

See what every Macmillan text holds for YOU.

See how "built-in" aids—lesson plans and practice, testing, and skill development programs, organized in convenient teaching units—help you teach *creatively*.

See how colorful, functional illustrations and clear type help you hold student attention. You can be sure, too, that each Macmillan text is authoritative and complete.

See how a variety of activities, plus, stimulating end-of-chapter materials for enrichment and review, helps you provide for individual student differences.

See how Macmillan texts can help you get the very best results from your classroom time.

ELLIOTT • WILCOX
Physics—A Modern Approach

BARNARD • EDWARDS
The New Basic Science

LENNES • MAUCKER • KINSELLA
A First Course in Algebra, 1957 Edition
A Second Course in Algebra, 1957 Edition

The Macmillan Company

60 Fifth Ave.
New York 11

2459 Prairie Ave.
Chicago 16

1360 Spring St. N.W.
Atlanta 9

501-7 Elm St.
Dallas 2

111 New Montgomery St.
San Francisco 5

ALGEBRA

FOR PROBLEM SOLVING

FREILICH • BERMAN • JOHNSON

Books 1 and 2

Books One and Two, a complete course in high school algebra that presents concepts, processes, and techniques thoroughly and clearly—a course that teaches for understanding as well as for use.

Abundant exercises, problems, and tests; reviews and summaries for each chapter; and effective use of a second color as a teaching aid are features of this unusually sound program—a program that efficiently meets today's classroom needs.

MAKING MATHEMATICS WORK

NELSON • GRIME

This general mathematics text reteaches arithmetic; explores practical problems, including budgeting, using a checking account, and buying on credit; and introduces statistics, geometry, and algebra.

Geared to the teaching plan and objectives of the text is an accompanying workbook, **Practice and Review Tests for Making Mathematics Work,** which contains interesting diagnostic tests that maintain and check skills as well as measure achievement.

HOUGHTON MIFFLIN COMPANY

BOSTON CHICAGO
NEW YORK ATLANTA
DALLAS PALO ALTO

TEACHERS COME WEST
Unexcelled Service. Largest in West.

Free Enr.

ROCKY MT. TEACHERS AGENCY

Wm. Ruffer, Ph.D., Mgr.

410 GUARANTY BANK BLDG., DENVER, COLO.

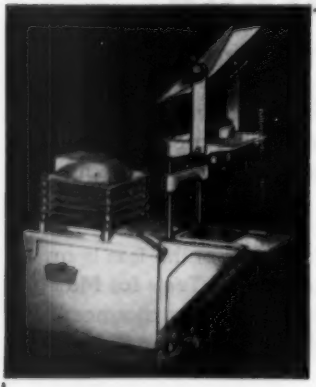
SINCE 1931 **SCIENCE FILMSTRIPS** SINCE 1931
MADE BY TEACHERS FOR TEACHERS
BIOLOGY • HEALTH & SAFETY • PHYSICS • GENERAL SCIENCE
CHEMISTRY • ATOMIC ENERGY • MICROBIOLOGY
NEW—Elementary Science Series in Brilliant Spectracolor
Box 599SSM **VISUAL SCIENCES** Suffern, New York

ADVERTISING PAYS

When your ads are run regularly in SCHOOL SCIENCE and MATHEMATICS
Our Rates are low. Compare them with other educational journals.
We reach the buyers of scientific apparatus and books.

Reserve space and send copy for our next issue to

SCHOOL SCIENCE AND MATHEMATICS Box 408, Oak Park, Ill.
Ray C. Soliday, Bus. Mgr.



The New KEYSTONE Overhead Projector

Classroom teachers have pronounced it

"the best all-around teaching projector we've ever seen . . . brighter, cooler and quieter, smaller and lighter."

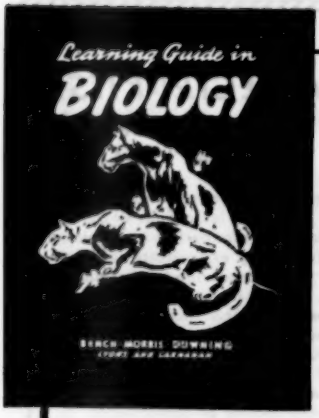
Refined optical system, with objective lenses and front condensing lens hard-coated—brighter illumination on screen.

Improved cooling system, pulling air on all sides of the lamp. Cools with lamp turned on, or with fan only to cool the lamp housing.

All attachments for the old Keystone Overhead are useable. It projects standard (3¼ in. × 4 in.) lantern slides, tachistoslides (4 in. × 7 in.) two-inch slides, hand-made slides, strip film and microscopic slides.

A note requesting a demonstration will bring our local representative to your school to show you this remarkable new Projector.

KEYSTONE VIEW COMPANY, Meadville, Penna.



Latest Edition
OF AN OLD FAVORITE!

- A STUDY GUIDE
- A PRACTICE GUIDE
- A REVIEW PROGRAM
- AN OBJECTIVE TESTING PROGRAM FOR USE WITH ANY TEXTBOOK

—a Lab Manual, but much MORE than a Lab Manual

By BENCH — MORRIS — DOWNING

LYONS and CARNAHAN

CHICAGO, ILLINOIS • WILKES-BARRE, PA.

ATLANTA DALLAS PASADENA PORTLAND

Why—

in a day when scientific training has never been in greater demand, is the number of science teachers DECLINING!

You'll find the long-needed help in meeting this acute problem in the new

Teaching Science in the Secondary School

by R. Will Burnett

Written by the author of the highly successful *Teaching Science in the Elementary School*, this new book contains a wealth of specific, practical teaching suggestions with illustrative examples from all fields of science. *Ready in April.*

Send for your examination copy now

And for training or guidance in mathematics teaching: —

Understanding Arithmetic
by R. L. Swain (April)

Teaching Mathematics in the Secondary School
by L. B. Kinney & C. R. Purdy. $5.00

An Introduction to the History of Mathematics
by Howard Eves. $6.00

The Theory of Numbers
by B. W. Jones. $3.75

Rinehart & Company, Inc. 232 MADISON AVE., NEW YORK 16

TREE OF KNOWLEDGE, 27¾" x 21" Wall Chart in Color. Price 75¢ each plus 20¢ Mailing Charge.

YOU WILL LIKE GEOMETRY, Illustrated pamphlet giving comprehensive presentation of the Mathematics Exhibit at the Museum of Science and Industry. Price 15¢ each plus 5¢ mailing charge.

Address:
Museum of Science and Industry
57th & South Shore Drive
Chicago 37, Illinois

CROW ELECTRI-KITS...
the practical, low cost approach to "VISUAL EXPERIMENT" ELECTRICITY

Crow Electri-Kits make electricity easy to teach and exciting to learn. Each kit contains complete apparatus for performing a related series of fascinating experiments plus a coordinated work-manual. The teacher demonstrates . . . then the students work the experiments themselves. This "learn by doing" method maintains interest at a high level and enables students to grasp quickly the relationship of one principle to another.

There's a Crow Electri-Kit designed specifically for either teacher or student use in:

Basic Electricity • Basic Electronics
Electronic Tubes, Circuits and Devices
Rotating Electrical Machinery
Electro-Dynamics

For detailed bulletins write

CROW ELECTRI-CRAFT CORP.
Division of Universal Scientific Co., Inc.
Box 3365 • Vincennes, Indiana



Introducing Gerry-Graph, fictitious animal and hero of 8 new filmstrips "Learning New Numbers—Fractions." For information and free preview write Filmstrip House, 347 Madisen Avenue, New York 17, N.Y.

HUFF TEACHERS AGENCY
Missoula, Montana
Member N.A.T.A.
42 Years' Placement Service

WESTERN STATES, ALASKA, HAWAII, FOREIGN
- Register Now. Opportunities are waiting.
- Grades, High School, College.
- Western Certification Booklet with FREE LIFE MEMBERSHIP

TEACH IN CHICAGO
SALARY SCHEDULE $4000 TO $7500 IN 13 STEPS
CREDIT FOR EXPERIENCE
FOR FULL INFORMATION WRITE
BOARD OF EXAMINERS
ROOM 342, 228 N. LA SALLE STREET, CHICAGO 1, ILLINOIS

Two Complete Revisions



SCIENCE

DAVIS • BURNETT • GROSS

For the ninth grade course in general science

MODERN PHYSICAL SCIENCE

BROOKS • TRACY

For the general—or *any* high school student who does not plan to take the separate courses in physics or chemistry

A Brand New Book



PLANE GEOMETRY

SCHACHT • MCLENNAN

HENRY HOLT AND COMPANY

383 Madison Avenue, New York 17

New York Chicago Dallas Atlanta San Francisco

IF . . .

you are planning a new School Science Department

. . . if you are broadening the activities of your present department

. . . these booklets can be of help to you. They contain carefully detailed lists of instruments, apparatus and supplies needed for a great variety of demonstrations and experiments in science courses. These lists are based on standard requirements and have been prepared by men long experienced in planning and equipping school science departments.

THEY'RE FREE! Write us today giving the name of each pamphlet desired. We'll send them promptly without cost or obligation.

- ◯ **Pamphlet ES-3** "Suggested List of Apparatus and Materials for Elementary Science."
- ◯ **Pamphlet GS-5** "Laboratory Apparatus for General Science."
- ◯ **Pamphlet B BR** "Laboratory and Demonstration Equipment for Secondary School Biology."
- ◯ **Pamphlet HSC-6** "Secondary School Chemistry List. (Including semi-micro apparatus)
- ◯ **Pamphlet P-10** "Secondary School Physics List."
- ◯ **Cenco Order Book** Lists 1500 items for Science, Biology, Chemistry and Physics.

CENCO

The most complete line of scientific instruments and laboratory supplies in the world

Central Scientific Company

1718-L IRVING PARK ROAD, CHICAGO 13, ILLINOIS

BRANCHES AND OFFICES: CHICAGO • NEWARK • BOSTON • BIRMINGHAM • DETROIT
SANTA CLARA • LOS ANGELES • REFINERY SUPPLY COMPANY - TULSA • HOUSTON
CENTRAL SCIENTIFIC CO. OF CANADA, LTD. - TORONTO • MONTREAL • VANCOUVER • OTTAWA